केंद्रीय भूमि जल बोर्ड

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भारत सरकार

Central Ground Water Board

Department of Water Resources, River Development and Ganga Rejuvenation, Ministry of Jal Shakti

Government of India

AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES

SUVARNAPUR DISTRICT, ODISHA

दक्षिण पूर्वी क्षेत्र, भुवनेश्वर

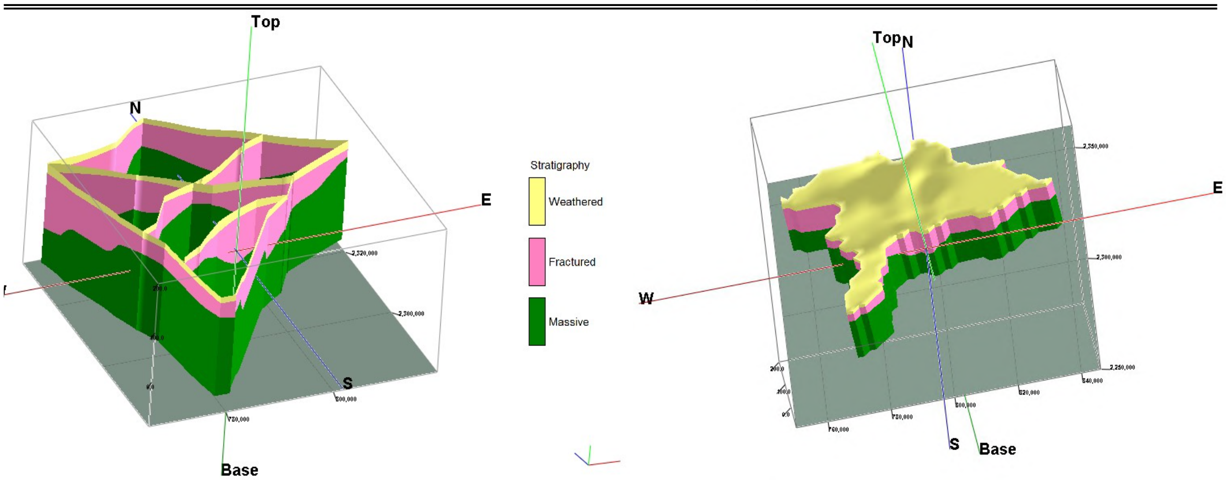
South Eastern Region, Bhubaneswar

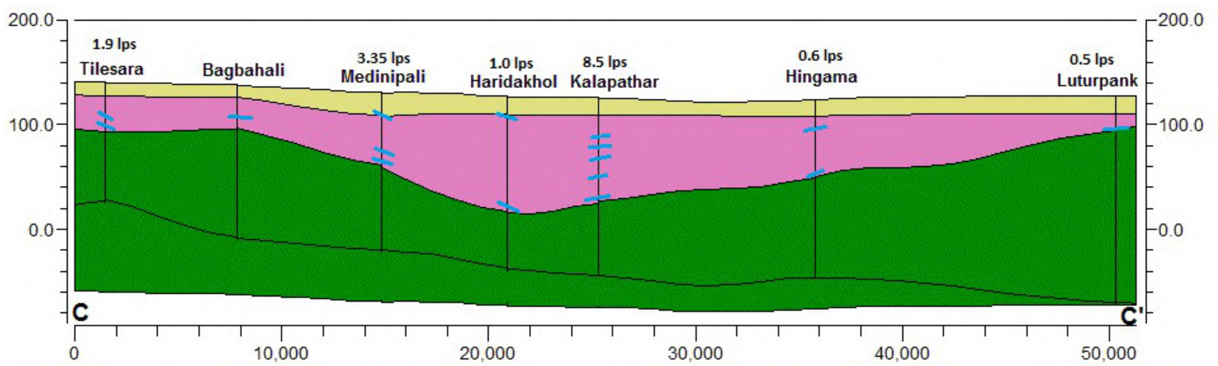
Government of India

MINISTRY OF JAL SHAKTI, DEPARTMENT OF WATER RESOURCES, RIVER DEVELOPMENT & GANGA REJUVENATION

REPORT ON

AQUIFER MAPPING AND MANAGEMENT PLAN IN SUVARNAPUR DISTRICT, ODISHA





CENTRAL GROUND WATER BOARD

South Eastern Region, Bhubaneswar

August-2021

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FOREWORD

Suvarnapur is one of the important districts of western Odisha, famous since prehistoric times as an ancient place of human habitation. In the year 1993, it was carved out of Bolangir and came into existence as a separate district. The district is endowed with vast natural resources and is one of the agriculturally developed districts of Odisha. The district is underlain mostly by hard crystalline formations of EasternGhat Supergroup. The river Mahanadi and its tributaries are the main surface water sources which provide water to the district. However, large part of the district still lacks surface water irrigation facility. The agrarian development of the district can be boosted by tapping the ground water resources through dug wells and medium-deep bore wells.

Due to wide variation in hydrogeological set up in the district, the occurrence and distribution of aquifers are non-uniform and so also their yielding properties. Proper site selection holds the key to the success of sustainable ground water development, which requires a thorough knowledge of hydrogeology and pattern of water usage in the terrain.

The hard crystalline rocks of the district form two distinct aquifer system. The shallow aquifer formed by the weathered mantle where water is stored under phreatic condition. The deeper aquifer is formed by fracture zones, joints etc where water occur in semi-confined condition. Granitic hardrock aquifers have water yielding fracture zones and have average success rate with 2-5 lps of discharge. Borewells in Anorthosites, charnockites and khondalites have very poor yield. The places where weathering thickness is more and condition is favourable, the phreatic aquifer attains good yield potential and large diameter dug wells are suitable structures to extract water from them.

The present stage of ground water development is only 45.58 %, leaving a vast scope for future ground water development in the district. Ground water irrigation practices can insure increased agricultural production by enhancing the area irrigated and scope of irrigation. Apart from irrigation, drinking water scarcity can also be mitigated through judicious utilization of ground water.

Based on the available data and the earlier hydrogeological studies taken up in 6 blocks of the district viz. Binika, Birmaharajpur, Dunguripali, Sonepur, Tarbha and Ullunda covering 1969 Sq. Km. of mappable area, an attempt has been made in this report to compile all relevant information, such as hydrogeological, agriculture, irrigation, land use, rain fall, chemical quality of water and other collateral data. **Shri D.N. Mandal, Scientist-'D'**, have compiled and prepared the present report on **"Aquifer Mapping and Management Plan in Suvarnapur District, Odisha"**. His sincere efforts in preparation of the report will no doubt be very useful and benefit the state. It is hoped that, it will be of immense help to different ground water user agencies, administrators and planners in preparation of ground water development plans and will be a handy tool in effective management of ground water resources in the district.

Place : Bhubaneswar
Date : 30th August 2021

(P. K. Mohapatra)
Regional Director

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1 INTRODUCTION

1.1 Objective

Central Ground Water Board (CGWB) has taken up National Aquifer Mapping and Management (NAQUIM) programme during the XIIIth five year plan to carry out integration of micro level hydrogeological, geophysical, hydrochemical data and information on geology, geomorphology, soil, hydrometeorology, hydrology, landuse, cropping pattern etc on a GIS platform to formulate district, block or aquifer-wise Ground Water Management Plan. The formulation of a sustainable ground water management plan would help in achieving the demand for drinking, irrigation and industrial need for water with minimal stress on the aquifer.

The activities under NAQUIM are aimed at identifying the aquifer geometry, aquifer characteristics their yield potential along with the quality of water occurring at various depths, aquifer-wise assessment of ground water resources and development. Aquifer mapping itself is an improved form of groundwater management – recharge, conservation, harvesting and protocols of managing groundwater.

With these aims, aquifer mapping was carried out in the hard rock terrain of Suvarnapur district in Odisha covering six blocks of the district namely, Binika, Birmaharajpur, Dungripali, Sonepur, Tarva and Ullunda.

1.2 Scope of the Study

Aquifer mapping is a multidisciplinary exercise wherein a combination of geological, geophysical, hydrological, hydrogeological, meteorological and hydro-chemical information is integrated to characterize the spatial and temporal variation of quantity and quality of the aquifer system and identification of local ground water related problems and issues.

To resolve such issues, the NAQUIM study was carried out with the following broad objectives: to define the aquifer geometry with precise lateral and vertical demarcation down to the depth of 200 mbgl, to define the behaviour of ground water regime in time and space, to study the hydraulic characteristics of both shallow and deeper aquifers, to study the hydrochemistry of aquifer systems, to prepare Aquifer Maps indicating disposition of aquifers along with their characterization and to formulate the Aquifer Management Plans for sustainable development and management of ground water resources.

1.3 Approach and Methodology

Multi-disciplinary approach involving geological, geophysical, hydrological, hydrogeological and hydro-geochemical survey would be carried out to meet the aim and objectives listed above. GIS would be used to prepare the maps.

The entire Suvarnapur district has been geologically mapped by the Geological Survey of India. Hydrogeological surveys have been conducted in different parts of the district by S/Shri P. K. Das (1982-83), G. K. Roy (1990-91), G. C. Pati (1994-95) and A. Subburaj (1994) of CGWB, SER on 1 : 50,000 scale.

1.3.1 Compilation of Existing Data and Identification of Data Gaps

Preliminary work will consist of the collection and review of all existing data which relate to the area. This usually included the results of previous hydrogeological studies and exploratory drilling carried out by CGWB and state agencies and compiled to identify the data gaps in the study area. After the data compilation all the data were integrated and analysed.

1.3.2 Hydrogeological Investigations

Review of background information leads the study teams to carry out further studies in the field, where they will employ various techniques to determine the three-dimensional extent and aquifer characteristics of the significant water-bearing formations. Key Observation wells representing the different aquifers have to be established and monitoring carried out. Well inventory and collection of relevant data are to be carried out to strengthen the data base. The analysis of the data will be carried out to prepare maps.

1.3.3 Geo -hydrochemical Investigations

Water Samples to be collected, analyzed and interpreted to bring out ground water quality scenario of the study area.

1.3.4 Generation of Thematic Layers Using GIS

Based on the available spatial data thematic maps of land elevation, drainage, soil, landuse, geomorphology, geology, hydrogeology, depth to water level, seasonal fluctuation of water level, water level contour, aquifer disposition, water quality parameters were prepared on GIS platform.

1.3.5 Development of Aquifer-Wise Management Plan

The dimension and disposition of the aquifer is figured out on the basis of integrated study of the geologic, hydrogeological, hydrological, geochemical and geophysical information. Determining aquifer potential and characteristics are essential for their effective management and sustainable development. Local ground water related issues should be identified and studied in detail to make plans to solve them.

1.4 Study area

During XIII five year plan, the National Aquifer Mapping and Management (NAQUIM) programme were taken up under Annual Action Plan (AAP) 2019-20, for detailed hydrogeological investigation and Aquifer Mapping in Suvarnapur district. Suvarnapur was awarded the status of a district in April 1993 after being carved out from the erstwhile Bolangir district and was renamed as Suvarnapur. It is one of the economically backward districts of Orissa and is presently under KBK region. Suvarnapur district is bounded by 83°26’11” E and 84°17’19” E longitudes and 20°31’50” N and 21°10’05” N latitudes covering 2337 sq. Km. under the SOI Toposheet Numbers 64 O/8, 12, 16; 64 P/5, 9, 10, 13, 14; 73 C/4 and 73 D/1. The total mappable area under NAQUIM is 1969 sq. Km, which was taken up for the study after excluding the hilly areas. The district is having 2 Subdivisions (Birmaharajpur and Sonepur), 6 administrative blocks (Binika, Birmaharajpur, Dungripali, Sonepur, Tarva and Ullunda), 4 towns (Sonepur Town - Municipality, Tarva Town - NAC and Binika Town – NAC and Subalaya-Census Town), 96 Gram Panchayats and 962 villages.

The study area forms a part of Mahanadi basin. The Mahanadi and its tributary the Tel together form the eastern boundary of Suvarnapur district. The district is bounded on the north by Bargarh and Sambalpur district, on the east by Sambalpur and Angul districts, on the south by Boudh district and on the west by Bolangir district of Orissa The district headquarter Suvarnapur is connected by all-weather metalled road from capital city Bhubaneswar (280 km) via Nayagarh, Boudh and from Anugul via Rairakhol and from Bolangir (42 km). Bolangir is the nearest railway station which is about 42 km from Suvarnapur. The block-wise areas under NAQUIM are enumerated in **Table-1.1**. The index map of the study area is presented in **Fig.1.1**, while an administrative map is presented as **Fig. 1.2**.

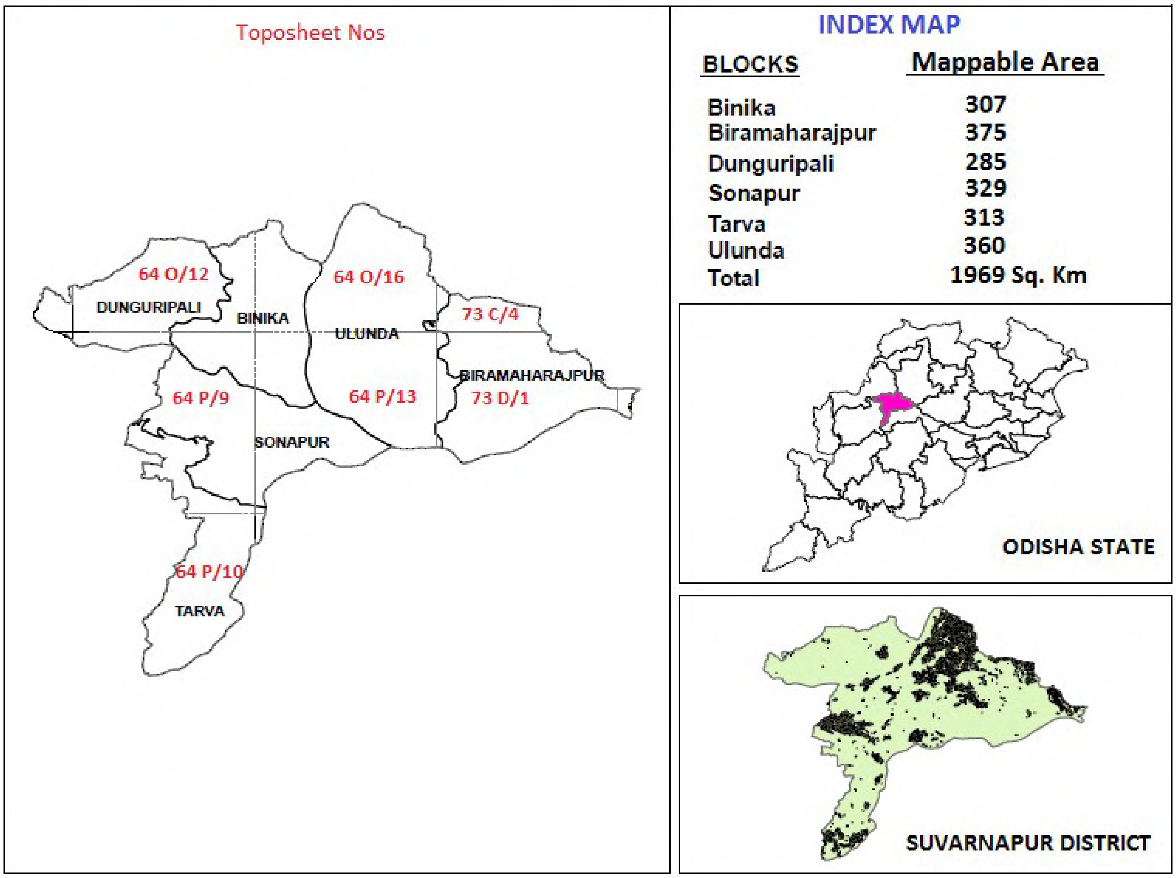


Fig. 1.1: Index Map of Study Area under NAQUIM in Suvarnapur District.

Table-1.1: Block-wise Areas Covered Under NAQUIM in Suvarnapur District.

Sl No.	Block	Geographic Area (Sq. Km)	Hilly Area (Sq. Km)	Mappable Area (Sq.Km)
1	Binika	341	34	307
2	Birmaharajpur	415	40	375
3	Dungripali	287	2	285
4	Sonepur	386	57	329
5	Tarva	328	15	313
6	Ullunda	580	220	360
	Total	**2337**	**368**	**1969**

The block-wise demographic details are shown in **Table-1.2**.

Table-1.2: Block-Wise Demographic Details in Suvarnapur District.

Sl No	Block	GPs	Villages	Population (2011)			Sex Ratio	Decadal growth rate		
				Rural	Urban	Total		Rural	Urban	Total
1	Binika	15	99	91118	15765	106883	953	7.87	8.43	7.96
2	Birmaharajpur	13	181	90304	5072	95376	953	9.33	-	15.47
3	Dungripali	21	112	123823	-	123823	945	6.74	-	6.74
4	Sonepur	13	159	80775	20770	101545	970	15.34	18.4	15.95
5	Tarva	18	184	84374	8334	92708	990	18.8	4.31	17.34
6	Ullunda	16	227	89848	-	89848	966	15.69	-	15.69
Total		**96**	**962**	**560242**	**29104**	**610183**	**961**	**11.65**	**-**	**12.61**

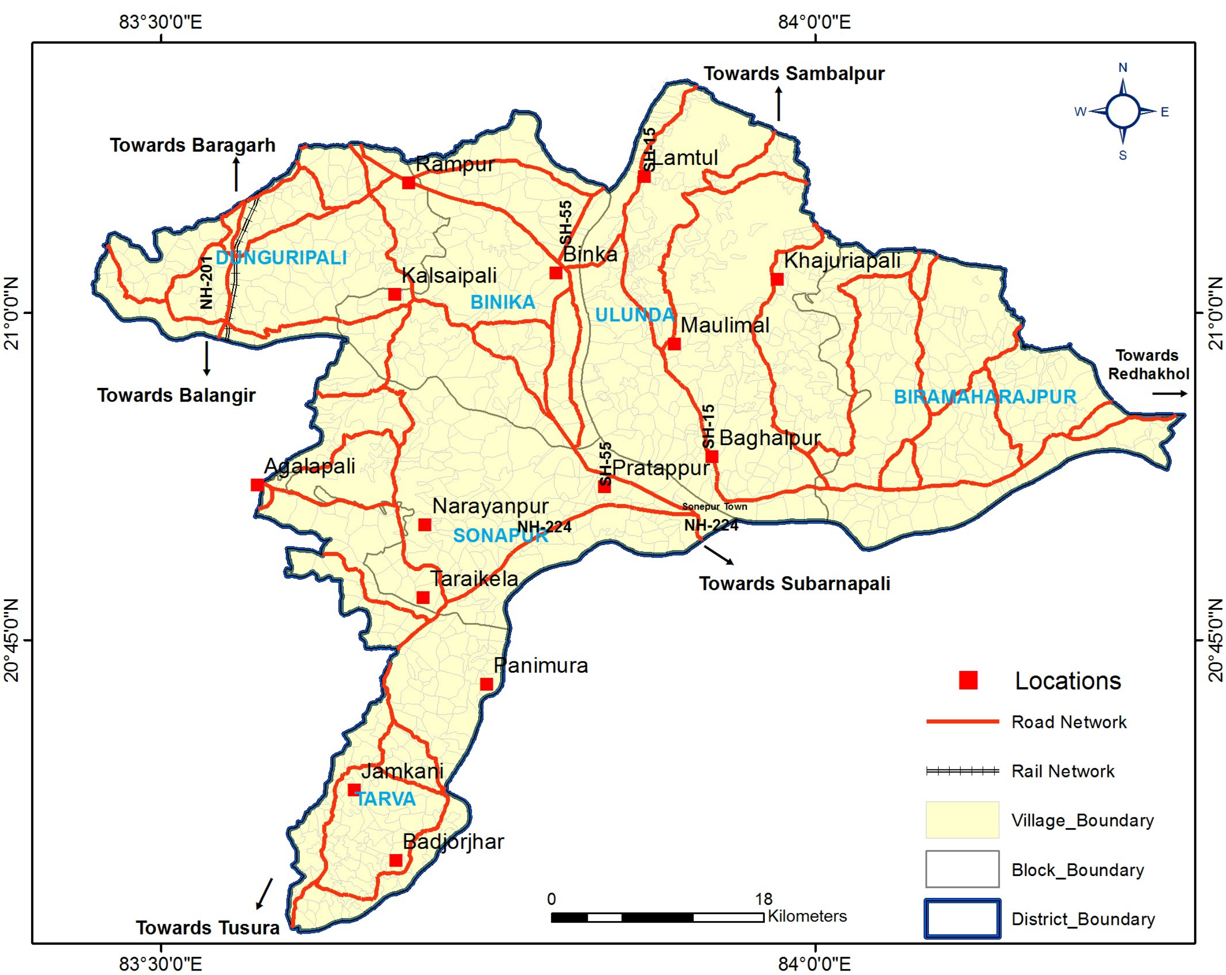


Fig. 1.2: Administrative Map of Suvarnapur District.

1.5 Climate and Rainfall

The district enjoys a humid sub-tropical climatic condition which is hot and dry in summer, cool and humid during the rainy season and cold and dry in winter. The maximum temperature varies from 34.3°C to 47.7°C. May is the hottest month with the mean daily maximum temperature of 41.4°C. December is the coldest month when temperature sometimes comes down to 6°C. The humidity of the area is generally high especially in the monsoon and pre-monsoon months. The Relative humidity varies from 26% to 84% during different periods of the year. The mean monthly potential evapo-transpiration value ranges from 45 mm in December to 470 mm during May.

The south-west monsoon is the principal source of rainfall in the area. The rainfall is erratic with uneven distribution resulting in drought and flood conditions. The normal rainfall of the district is 1418.5 mm. There are on average 67 rainy days in a year. About 87% of the annual rainfall occurs during monsoon period between June to October. Generally the monsoon breaks in the middle of June and continues till the end of October, which forms the rainy season. The result of block-wise long term analysis of rainfall is presented in **Table 1.3** and long term analysis of rainfall in Suvarnapur district is shown in **Fig. 1.3**.

Table 1.3: Long-term Rainfall Analysis of Suvarnapur District.

Sl No	Station	No of Years	Average Annual Rainfall (mm)	Coefficient of Variation (%)	Droughts No of yrs/(% of Tot. Yrs)			Rainfall Received No of yrs(% of Tot. Yrs)		Rainfall Trend (mm/year)
					Moderate -25 to -50% Departure	Severe -50 to -75% Departure	Acute above -75% Departure	Normal -25 to +20% Departure	Excess > +25% Departure	
Long Period (1989-2018)										
1	Binika	30	1355.2	40	8 (27%)	2 (7%)	0	11 (36%)	9 (30%)	+7.44
2	Birmaharajpur	30	1414.5	28	4 (13%)	0	0	20 (67%)	6 (20%)	-6.35
3	Dungripali	30	1222.6	27	7 (23%)	0	0	17 (50%)	6 (20%)	+3.54
4	Sonepur	30	1428.4	22	4 (13%)	0	0	21 (70%)	5 (17%)	-7.57
5	Tarva	30	1440.5	24	5 (17%)	0	0	21 (70%)	4 (13%)	-1.37
6	Ullunda	30	1278.0	30	4 (13%)	0	0	20 (67%)	6 (20%)	-10.65
	District Avg	30	1356.53							
Decadal (2009-2018)										
1	Binika	10	1238.8	36	2 (20%)	1 (10%)	0	5 (50%)	2 (20%)	-20.44
2	Birmaharajpur	10	1371.5	23	0	0	0	8 (80%)	2 (20%)	+15.59
3	Dungripali	10	1260.7	26	2 (20%)	0	0	7 (70%)	1 (10%)	-25.86
4	Sonepur	10	1361.9	17	0	0	0	9 (90%)	1 (10%)	+10.36
5	Tarva	10	1411.2	24	1 (10%)	0	0	8 (80%)	1 (10%)	-0.68
6	Ullunda	10	1224.0	31	2 (20%)	0	0	6 (60%)	2 (20%)	+62.4
	District Avg	10	1311.35							

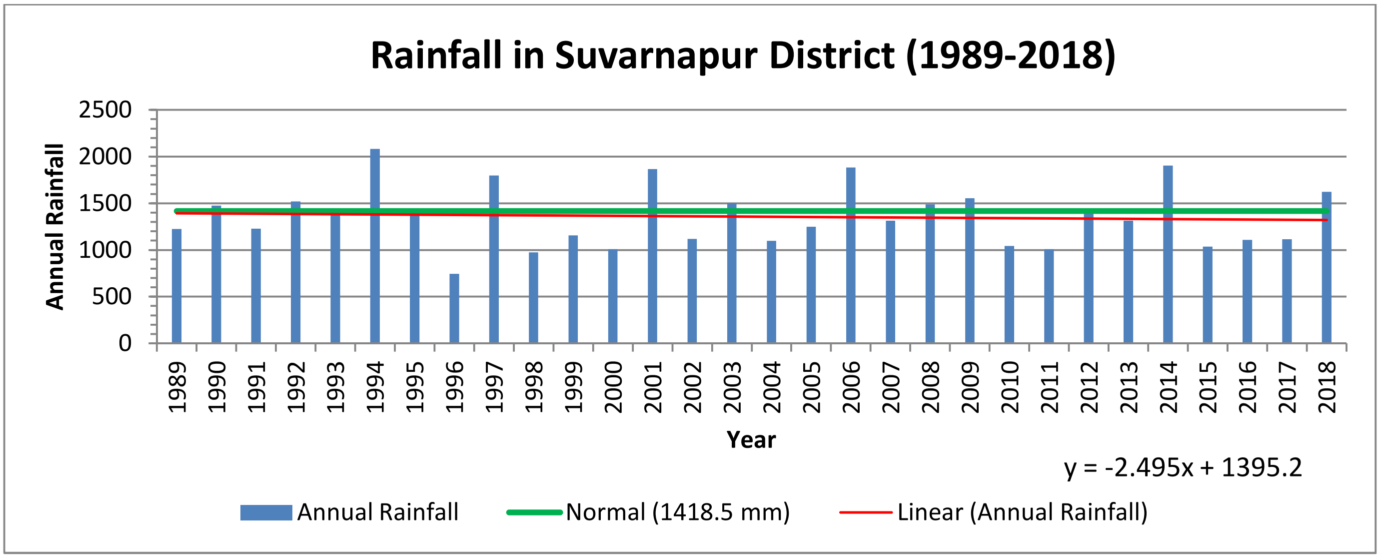


Fig. 1.3: Long-Term Analysis of Rainfall in Suvarnapur District.

Perusal of **Table 1.3** shows that

1. The coefficient of variation in rainfall is higher in Binika block for both long period and decadal analysis indicating erratic rainfall in this block.
2. Moderate draught conditions with -25 % to -50% rainfall departure has been observed in less than 30% of years in all blocks as per 30yr long period analysis. Binika block has witnessed very severe drought conditions in 10% of the years.
3. Normal rainfall has been received in 36% to 70 % of the years over 30 years long period however in the last decade normal rainfall is received in 50 to 90% of the years.
4. The data indicates that the rainfall in Binika block has highly declining decadal trend of -20.44%. Tarva block has very little change of rainfall trend during the entire period from 1989 to 2018 with the rainfall variation of 24% of the mean rainfall value.
5. The mean decadal rainfall received by the district is 1311 mm/yr, whereas the mean for 30 yrs period is 1356.53 mm/yr which shows that the rainfall in the district is slightly reduced during the recent years.

The Isohyetal Map of the district is shown in **Fig. 1.4**.

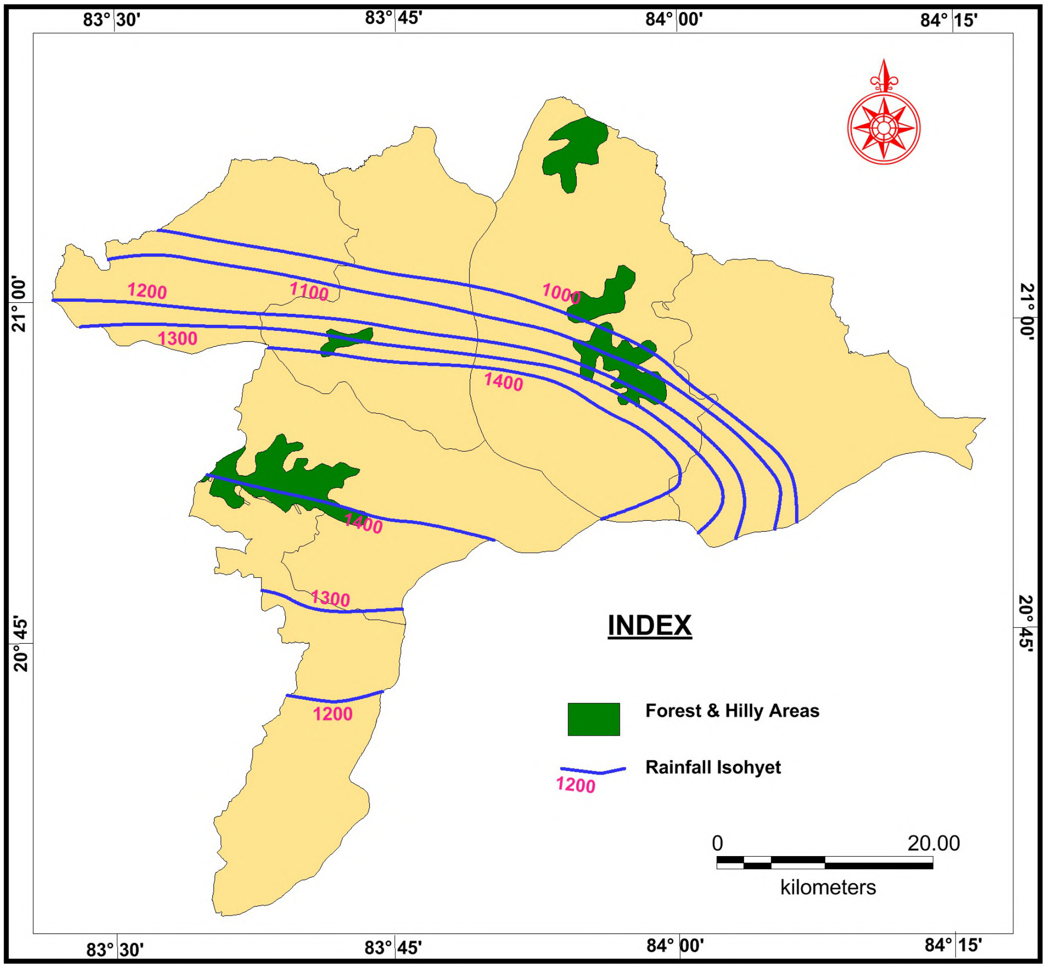


Fig. 1.4: Rainfall Isohyets in Suvarnapur District.

1.6 Physiographic Setup

Physiographically, the district comprises of undulating plains dotted with residual hills and mounds except few patches of scattered and high relief areas in the east-central and northern parts. A gently undulating terrain with a vast stretch of cultivable land characterizes the major parts of the district, the average land elevation being 200 m to 300 m above mean sea level. The variation in land elevations above MSL is shown in **Fig. 1.5**.

1.7 Geomorphology

The geomorphology of the area is shown in **Fig. 1.6.** The study area comprises of the following geomorphic units.

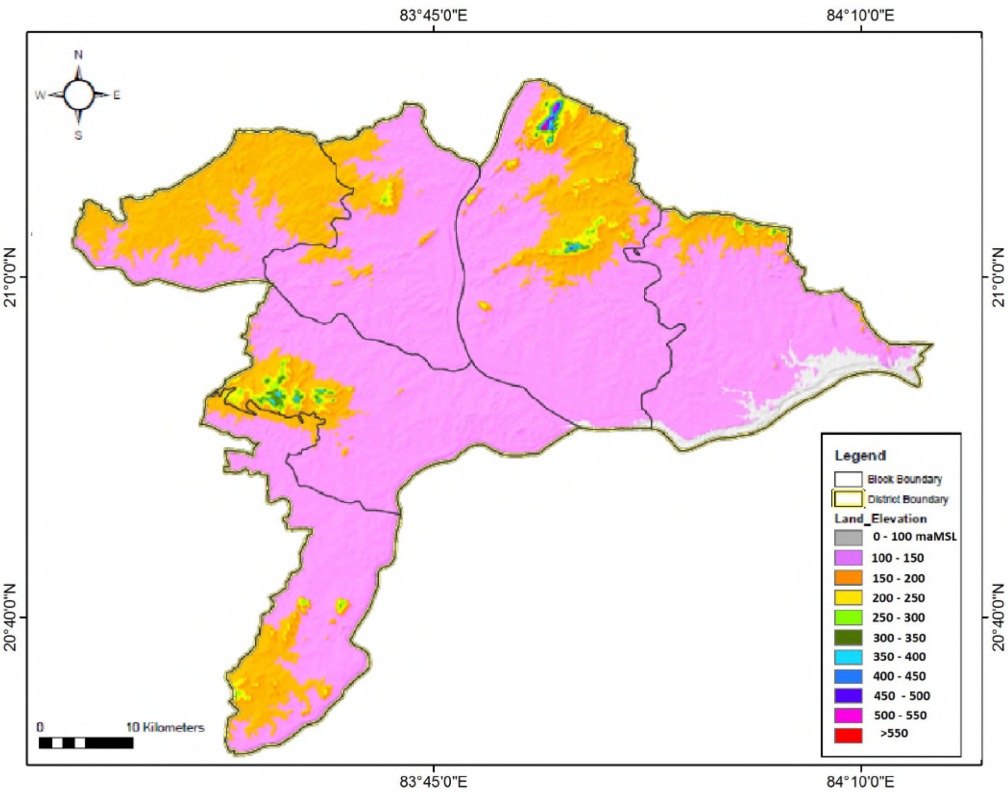


Fig. 1.5: Land Elevations in Suvarnapur District.

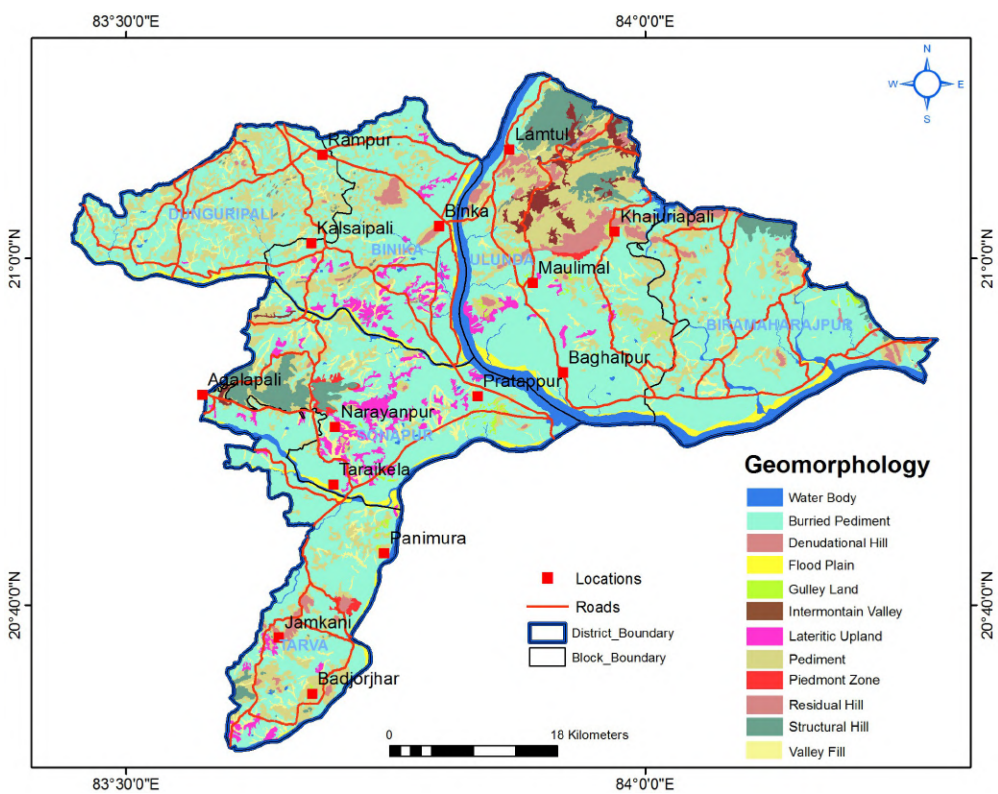


Fig. 1.6: Geomorphology of Suvarnapur District.

1.7.1 Flood Plains

They occur along a narrow stretch with limited thickness and areal extent along the course of Mahanadi and its tributary Tel. They comprise of loose unconsolidated materials like sand, silt, clay, pebbles, boulders etc. Fine to coarse sand form potential aquifer zones and yield a good quantity of water. Ground water in these areas may be developed through dug wells and shallow tube wells.

1.7.2 Buried Pediments

This is the most extensive, common unit in the area covering parts of each block of the district. They are characterized by thick weathered zone with thickness varying from less than 10 to 15 m and forms potential phreatic aquifer. Ground water development can be through dug wells and dug-cum-bore wells.

1.7.3 Intermontane Valleys

A number of intermontane valleys with major rivers and their tributaries have developed viz. Salki, Bagh, Kharag etc which have been formed by deep incise weathering of denudational hills.

1.7.4 Valley Fills

These hydromorphic units are confined to linear depressions, which mostly contain fractured rock fragments and acts as very good area for storage and movement of ground water. Dug wells located in these areas yield fairly a good amount of water.

1.7.5 Structural Hills

The hills with escarpment characterize the feature steep slopes and narrow gorges. These are structurally controlled hills with complex folding, faulting and traversed by numerous joints/fractures facilitating infiltration and mostly act as run-off zone.

1.7.6 Residual Hills

This unit mainly consists of residual masses of granites. This unit behaves as a runoff zone.

1.7.7 Denudational Hills

Denudational hills are identified by their high relief representing resistant hill ranges. Rate of infiltration is very poor except along fractures/joints. These generally act as run-off zone.

1.8 Landuse, Cropping and Irrigation Pattern

Suvarnapur district comes under Western Central Table zone comprising two types of agro-climatic situations (1) Irrigated- Binka and Dunguripali. (2) Rainfed – Tarbha, Sonepur, Birmaharajpur and Ullunda.

Production and productivity of paddy is also much higher in Suvarnapur district. Cotton is predominantly grown in the Black soil of Birmaharajpur and Ullunda Blocks, which has a good market demand for its quality staples. Besides, the Mixed Red and Black soil favour cultivation of a variety of cereals, pulses, oilseeds, vegetables and fruits.

The study area shows wide variation in the pattern of land utilization. The Cropping Intensity of the district is 190%. The forest area is about 17.5% of total geographical area. The net sown area is highest in the Dunguripali block. The block-wise landuse pattern for year 2010-11 is shown in **Table 1.4** and the thematic map on landuse is shown in **Fig. 1.7**.

Table 1.4: Land Use Pattern in Suvarnapur District (2010-11).

(Area in hectares)

Block	Forest area	Misc. tree crop & grooves	Permanent pasture & grazing land	Culturable waste	Land put to non-agriculture use	Barren and Uncultivable land	Current fallows	Other fallows	Net Sown Area
Binika	707	2	1200	735	3155	784	917	589	18494
Birmaharaj	3898	8	1332	1110	4807	214	2524	2505	17274
Dungripali	642	142	1214	390	3102	529	1264	625	21687
Subarnapur	4570	75	743	3330	2898	1966	622	701	15666
Tarbha	799	61	1377	292	4460	308	3790	1436	17009
Ullunda	3853	42	1814	2090	6612	107	906	3594	14011
Total	14469	330	7680	7947	25034	3908	10023	9450	104141

Source:District Statistical Handbook, Suvarnapur 2011

Agriculture is the main stay for the rural population of the district. The cultivation is mainly in the Kharif season. Rabi cultivation is restricted to areas with irrigation facilities. The different crops grown in the area are cereals, coarse cereals, pulses, oil seeds, fbers, vegetables, spices, sugarcane, tobacco etc. The major crop of the district is paddy. As per the data available for the year 2013-14, the cropped areas under Kharif and Rabi seasons and available irrigation in these areas are shown in **Table 1.5**. The block & area-wise irrigation status is given in **Table 1.6** and the source-wise irrigation status is given in **Table 1.7**.

Table 1.5: Area (in Ha) Under Agriculture in Suvarnapur District.

Season/Area Type	Irrigated	Rainfed	Total
Kharif Cropped	80650	65050	145700
Rabi Cropped	42650	34410	77060
TOTAL	123300	99460	222760

Source: District Irrigation Plan, Sonepur, March 2016

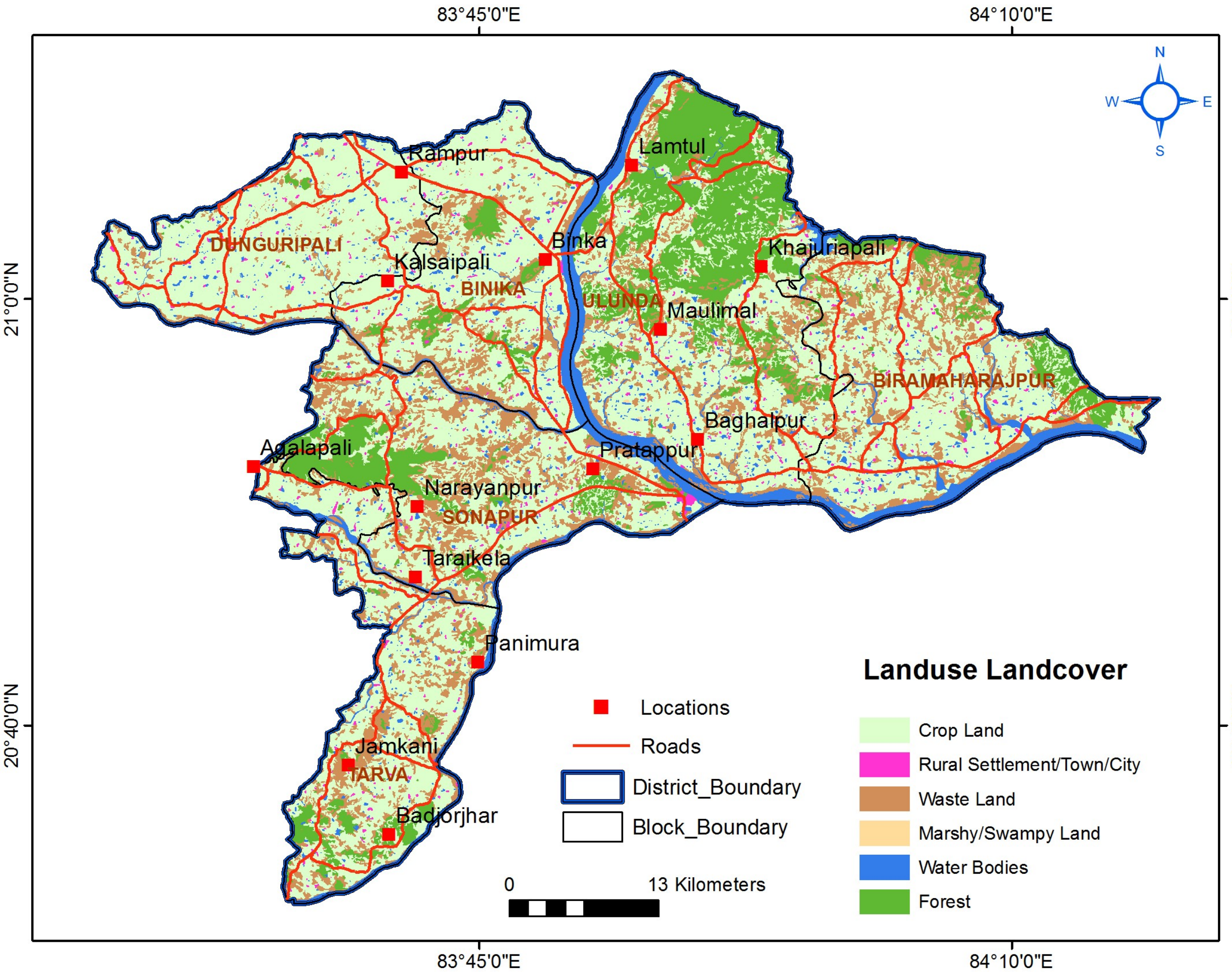


Fig. 1.7: Landuse in Suvarnapur District.

Table 1.6: Area-wise Irrigation Status in Suvarnapur District. (in Ha)

Block	Kharif			Rabi			Summer			Total		
	Irrigated	Rainfed	Total	Irrigated	Rainfed	Total	Irrigated	Rainfed	Total	Irrigated	Rainfed	Total
Binika	18750	405	19155	2960	3736	6696	12000	12000	24000	33710	16141	49851
Birmaharajpur	7867	16255	24122	2904	5420	8324	0	0	0	10771	21675	32446
Dunguripali	23022	281	23303	1807	1615	3422	18395	0	18395	43224	1896	45120
Sonepur	8964	10427	19391	4433	7262	11695	0	0	0	13397	17689	31086
Tarbha	4771	16873	21644	2649	4528	7177	450	145	595	7870	21546	29416
Ullunda	10785	11605	22390	3324	8278	11602	0	0	0	14109	19883	33992
Total	74159	55846	130005	18077	30839	48916	30845	12145	42990	123081	98830	221984

Source: District Irrigation Plan, Sonepur, March 2016

Table 1.7: Source-wise Irrigation Status in Suvarnapur District. (in No.)

Block	No. of Sources						
	Ground Water			Surface Water			
	Borewell (Govt)	Borewell (Private)	Total GW Sources	Community Pvt. Canals	Community Ponds	Individual/ Pvt. Ponds	Total SW Sources
Binika	0	320	320	190	200	25	415
Birmaharajpur	0	611	611	0	108	236	344
Dunguripali	0	191	191	0	32	10	42
Sonepur	0	605	605	0	25	0	25
Tarbha	220	710	930	250	790	210	1250
Ullunda	0	363	363	0	227	179	406
Total	220	2800	3020	440	1382	660	2482

Source: District Irrigation Plan, Sonepur, March 2016

1.9 Soil

Soils of the district are generally having average to good fertility status. All common types of crops can be grown in the district. The soil map of Suvarnapur district is shown in **Fig. 1.8**. Based on the physical and chemical characteristics, mode of origin and occurrence, soils of the district can be grouped into following types:-

1.9.1 Alfisols

The Alfisols include red sandy soils, red loamy soils, mixed red and black soils. These soils occur in major parts of the district. They are neutral to slightly alkaline in nature. The characteristic features of red soils are (i) light texture, porous and friable structure, (ii) absence of lime kankar and free carbonates and (iii) soluble salts in small quantity usually not exceeding 0.05 %. These soils are suitable for cultivation of paddy and other crops.

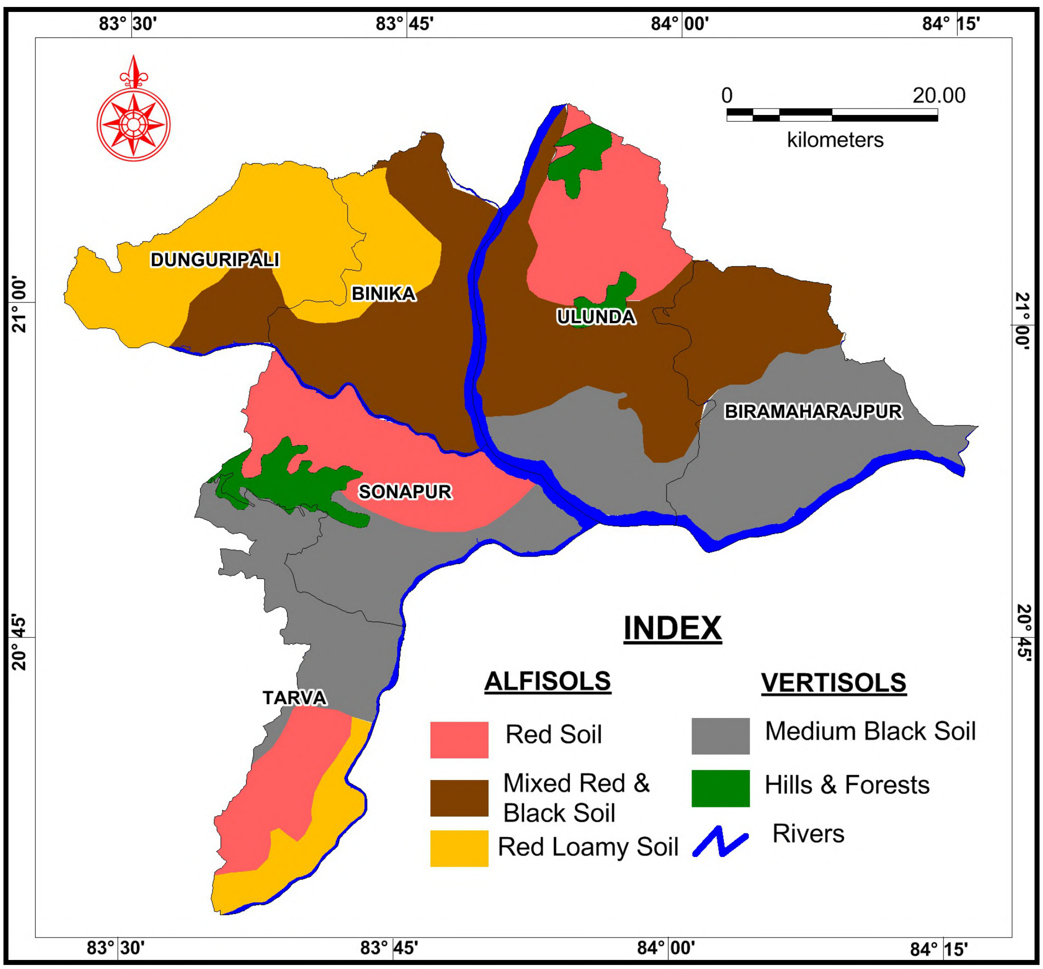


Fig. 1.8: Soil Map of Suvarnapur District.

1.9.2 Vertisols

These are medium black soils found around the course of Mahanadi and Tel rivers in the southern part of the district. They are highly argillaceous and contain high amount of iron, calcium and magnesium. They are usually poor in nitrogen, phosphate and organic matter but rich in potash and lime. The pH varies from neutral to alkaline and texture varies from loam to clay loam. They are quite fertile soils and crops grown are usually cotton, wheat, tobacco and chilly.

1.10 Drainage and Hydrology

The river Mahanadi, Tel and their tributaries constitute the main drainage system of the district. The tributaries are ephemeral in nature. The Mahanadi flows right through the heart of Subarnapur district. The other prominent rivers which traverse the territory are the Tel and Ong. They drain water from different parts of the area through small tributaries and ultimately flow into the Mahanadi at Sonepur. Among other rivers Jira, the northernmost affluent river discharges water into Mahanadi. Besides Surubali jore, Harihar jore, Badjore and Balijore are rainfed rivulets that flow in Subarnapur. The drainage map of the district is shown in **Fig. 1.9**.

Though agriculture in this district mainly depends on rain, irrigation facilities are provided through various irrigation schemes. The district has no major irrigation project except one Medium Irrigation Project i.e. Hariharjore Irrigation Projects in Birmaharajpur block which commands an area of 2600 Ha in Birmaharajpur Block and 6850 Ha in Ullunda Block. But there are three Major Irrigation Projects in the neighbouring districts, namely Hirakud Irrigation project in Sambalpur district, Ong Irrigation Project in Bargarh District and on-going Lower Suktel Irrigation project in Bolangir District. The Hirakud Irrigation Project covers an ayacut area of 22329.02 Ha in Dunguripali block and 20511.18 Ha in Binka block. The Ong Irrigation Project covers an area of 5029 Ha in Sonepur block and the Lower Suktel Irrigation Project will cover an area of 1988 Ha in Subarnapur district after completion. Apart from that the Ong Extension Project has been taken up which will cover an additional area of 7445 Ha of the district after completion. There are 58 storage schemes in Minor Irrigation Sector. Besides there are 794 Lift Irrigation (LI) projects with designated ayacut area of 20213 ha out of which 751 projects are in operation and they irrigate 18297 ha.

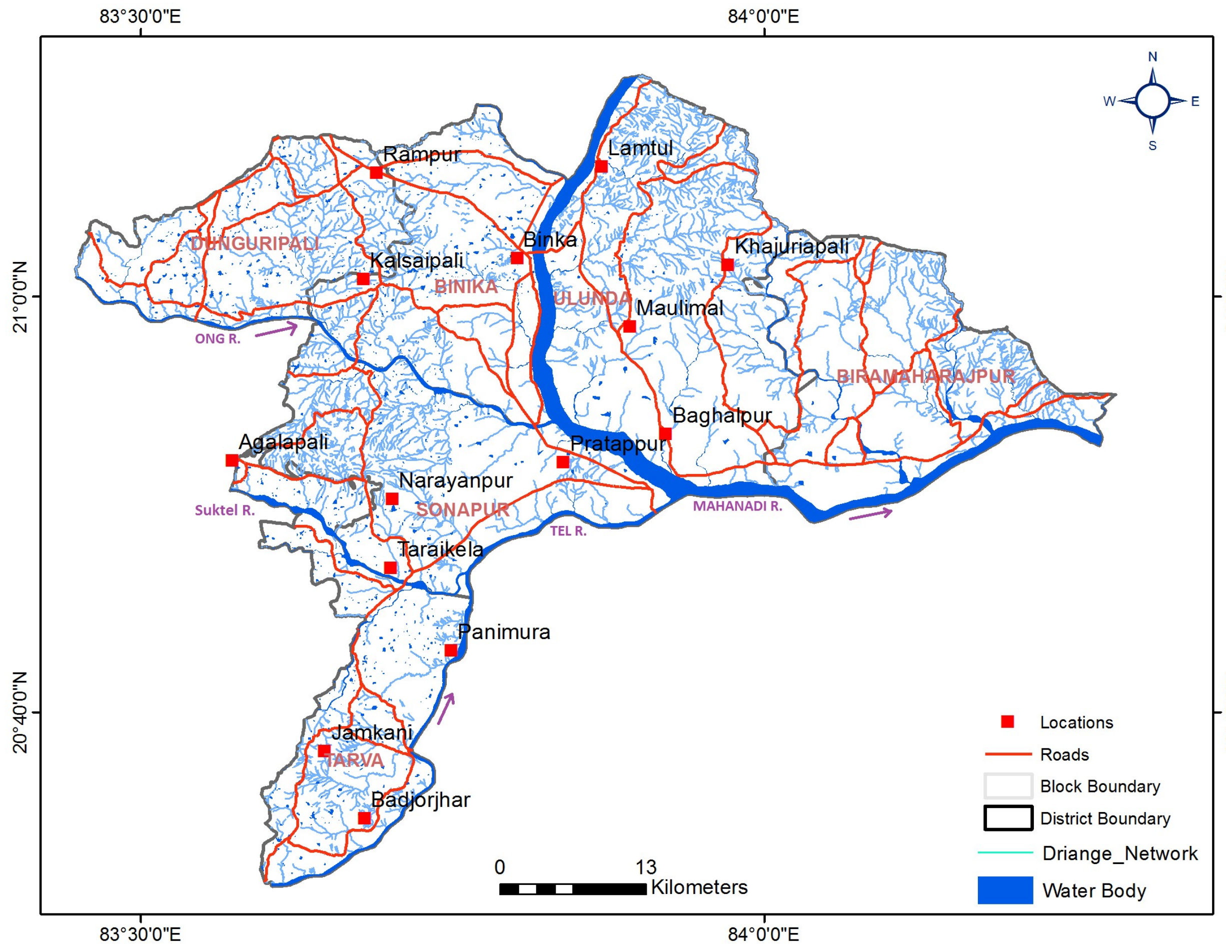


Fig. 1.9: Drainage Map of Suvarnapur District.

The block-wise details of Minor Irrigation Projects (MIP) in the study area are given in **Table 1.8.**

Table 1.8: Block-wise MIPs in Suvarnapur District. (As on 31.12.2013)

Sl. No.	Block	No of Projects	Catchment Area (Sq.km)	Ayacut Area (Ha)		
				Kharif	Rabi	Total
1	Birmaharajpur	14	71.07	1717	137	1854
2	Sonepur	12	27.37	848	88	936
3	Tarbha	11	222.43	3307	-	3307
4	Ullunda	21	60.89	1617	41	1658
	Total	**58**	**381.76**	**7489**	**266**	**7755**

Source: Dept. of Water Resources, Minor Irrigation Projects, Odisha 2014

2 DATA COLLECTION AND GENERATION

2.1 Geology

The study area forms a part of the Peninsular crystalline complex. The district is underlain by Precambrian crystallines, metamorphics, intrusives and sedimentaries of Permo-Carboniferous age and Recent laterites and alluvium. The generalized stratigraphic sequence is given in **Table 2.1** and the geological map of the study area is shown in **Fig. 2.1.**

Table 2.1: **Generalized Stratigraphic Sequence in Suvarnapur District.**

Group/Formation	Lithology	Age
Alluvium/ Laterite	Sand, silt, clay, Laterite	Quartenery Recent to Sub-recent
~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~	~ ~~~ ~ ~ ~ ~ ~ Unconformity ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~	~ ~ ~ ~ ~ ~ ~ ~ ~
Lower Gondwana	Sandstone, siltstone, shale, conglomerate	Permian to Upper Carboniferous
~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~	~ ~~~ ~ ~ ~ ~ ~ Unconformity ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~	~ ~ ~ ~ ~ ~ ~ ~ ~
Easternghat Super Group	Anorthosite, Gabbro, Pegmatite, Quartz Veins, Bonai Granite, Gorumahisani Group- quartzites and gneisses, Granite and granite gneisses, Charnockite and Khondalite	Precambrians

Khondalite Suite of Rocks: They are exposed in small parts in the north-eastern and western part of the district forming hills. These comprise of quartz-garnet-sillimanite schists, gneisses, garnetiferous- sillimanite-quartzite and calc-silicate granulitic rocks. The typical Khondalites are reddish brown in colour with specs of pink or red garnets and sillimanite needles aligned to schistosity of the rock units. The rocks are medium to coarse grained in texture, well foliated. These have been extensively weathered with the depth of weathering varying from 8.5 to 30 m depending on the topography.

Charnockite Suite of Rocks: These occur as isolated hills and are not extensively developed in the district. Weathering is not pronounced and foliations and joints are not well developed. The depth of weathering in the rocks ranges up to 15m depending on the topographic situation.

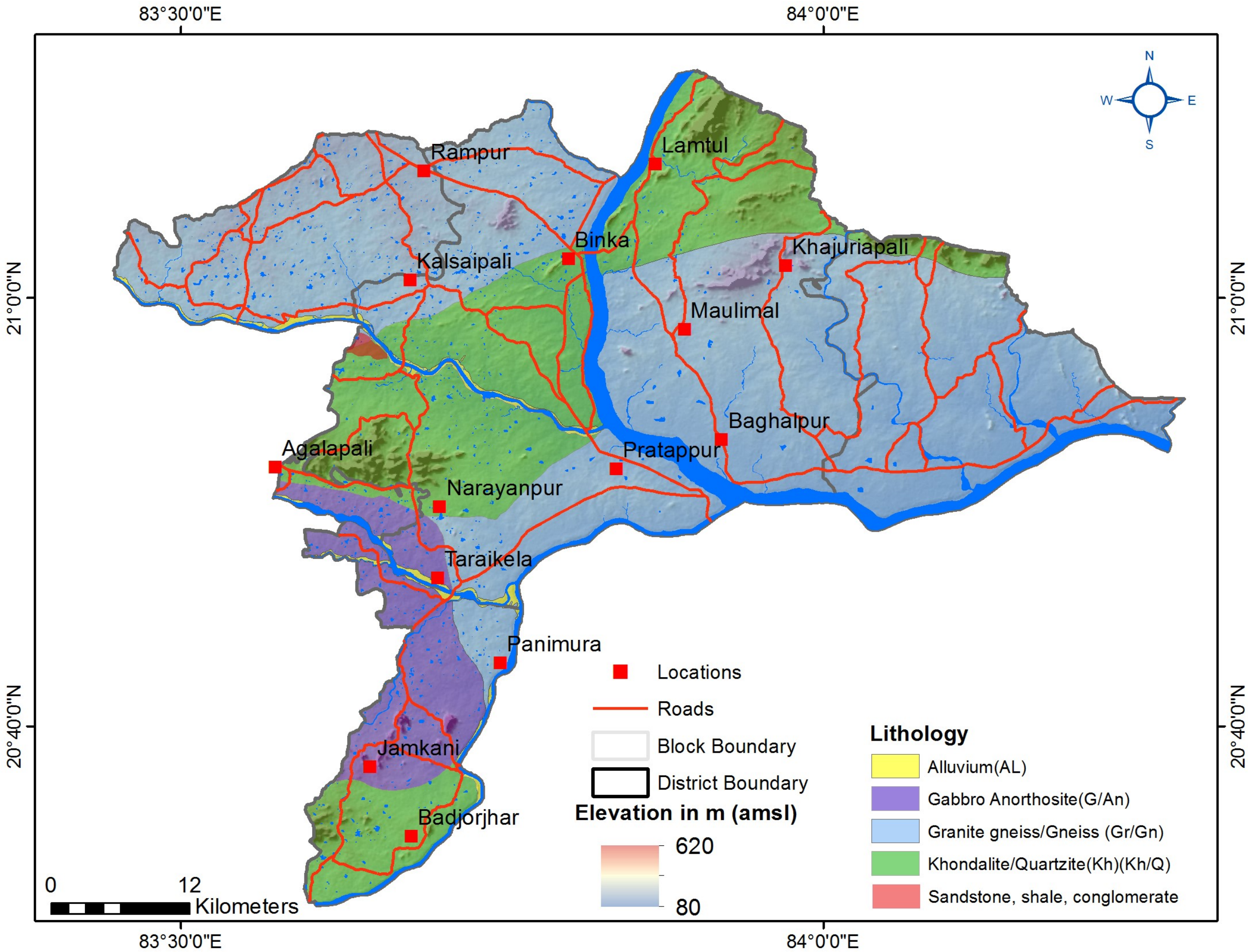


Fig. 2.1: Geological Map of Suvarnapur District.

Granite and Granite Gneiss: These are predominant rock types in the district forming undulating plains. These are light grey to grey in colour, fine to coarse grained and composed of quartz, feldspar, biotite and garnet etc. They exhibit well developed foliations and joints but at places are compact and massive. The depth of weathering is quite extensive and the thickness of weathered zone may be up to 32 m depending on the topographical situation.

Other Crystalline Rocks: They include Gorumahisani Group of quartzites and gneisses and Bonai granites occurring in the north-western part of district in the area in between the Ong and Mahanadi rivers. The gabbro-anorthositic rocks are encountered in the southwestern part of the district. These are light to dark coloured, medium to coarse grained and are composed of plagioclase feldspars, biotite, pyroxene, garnet etc. These are generally hard and massive in nature. In addition to these a number of quartz and pegmatite veins occur as intrusive in the district. These are coarse grained and hard which form good aquifers when fractured and friable.

Lower Gondwanas: These rocks occur in the western part of the district south of river Ong covering small part of Sonepur block. They comprises of sandstones, siltstones, shales and conglomerates etc. The sandstones are fine to coarse grained, grey to brown in colour and show ripple marks and current bedding. The shales are compact, greenish to brownish in colour. The conglomerates are intra-formational and contain subrounded pebbles of granite gneiss in a ferruginous and clayey matrix. The Gondwana formations have faulted contacts with the Precambrians.

Alluvium and Laterites: The Quaternaries include laterites and alluvium. The laterites occur as a cap rock over all kind of formations in the undulating plains and also in the valleys. These are found below the soil cover with the depth ranging from 1 to 3.5 m. They are highly porous and permeable. Alluvium consisting mainly of sand, gravel, silt and clays occurs in the close vicinity of the major drainage channels like the Mahanadi and Ong rivers.

Structure: The regional trend of foliation and schistosity of the Easternghat Group is NE-SW, NNE-SSW and E-W. Foliation dips are steep (60^0 to 80^0 to almost vertical) towards north and northwest. The Precambrian rocks are well jointed. The common joints are N-S, E-W, NE-SW and NNW-SSE with steep dips. The Gondwana formations occupy down faulted troughs with beds dipping at low angles varying from 10^0 to 20^0.

2.2 Hydrogeology

The geological formations of the district have diverse lithological composition and structure. Hence the hydrogeological condition too shows wide variations. Depending upon the geology, water bearing and water yielding properties, three major hydrogeological units have been identified in the district.

These are: Consolidated formations,
Semi-consolidated formations and
Unconsolidated formations.

Rainfall, climate, topography, depth of weathering, soil condition and landuse are the other factors controlling the ground water potentials of the area. The hydrogeological map of the area is presented in **Fig. 2.2**.

In the major part of district groundwater occurs under phreatic and semiconfined conditions, the water being stored in the secondary conduits viz. weathered mantle, fractures and joint planes etc. Infiltration of atmospheric precipitation is the principal source of ground water recharge. Besides other contributory sources are the seepage from irrigation canals, return seepage from applied irrigation and seepage from the reservoirs. Most of the rainfall in the hilly terrain goes as surface run-off where as in the moderately undulating plains and valley areas, rainfall contributes significantly to the ground water recharge to form potential aquifers under favourable conditions.

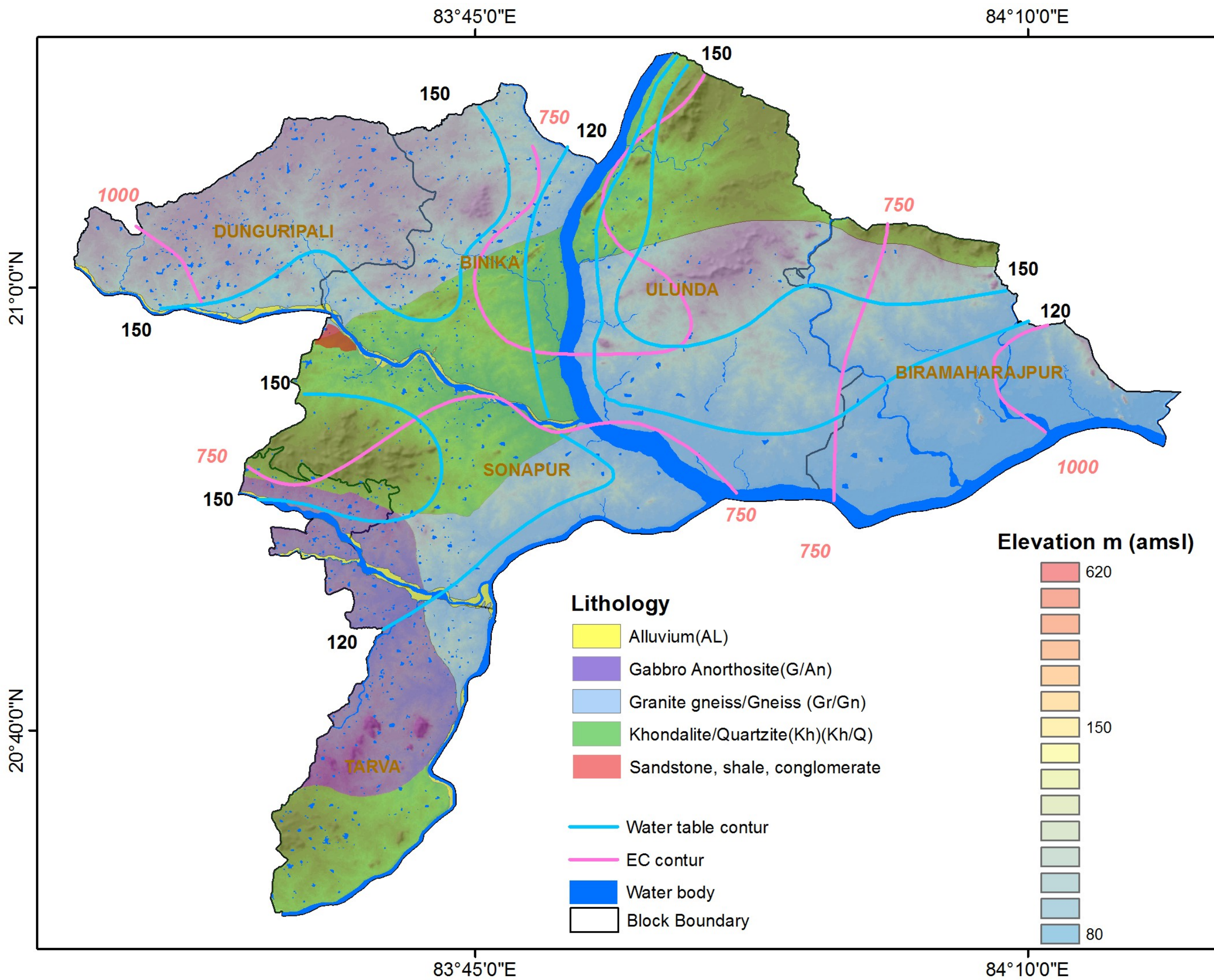


Fig. 2.2: Hydrogeological Map of Suvarnapur District.

2.2.1 Water Bearing Formations

A. Consolidated and Fissured Formation

Except for a small patch in the western part underlain by Lower Gondwana formations and small strips of alluvium along major rivers, almost the entire district is occupied by the consolidated formations. These rocks lack primary porosity. Weathering plays an important role in ground water occurrence and movement in these rocks by developing secondary porosity. Under favourable conditions the weathered residuum forms potential phreatic aquifer. The fissures and joints, when interconnected depending on the extent, size, openness, continuity and interconnection form potential ground water repositories at favourable locales. Ground water occurs under water table conditions in the weathered zones while it occurs under semi-confined conditions in the deeper fracture zones. Usually two to four water bearing fracture zones occur down to the depth of 100 mbgl.

Granite Gneiss and Its Variants: Granite and granite gneiss are the most predominant rock types in the district occupying undulating terrain and low lying areas. The weathered zone acts as good repository of groundwater. These rocks are weathered to form a heterogeneous mixture of clayey and granular materials ranging in depth from 5 to 30m depending upon the mineralogical composition and topography. Ground water potential of this unit is quite significant because of open nature of joints and porous nature of the weathered residuum. The irrigation wells are constructed with a large diameter in the topographic lows. The specific-capacity of the wells vary from 6 lpm/m to 286 lpm/m drawdown. Bore wells generally yield within 2 lps and occasionally higher upto 25 lps.

Charnockites: There is very limited occurrence of charnockite in the district. The weathering in these rocks is neither uniform, not extensive and the joints and foliations are not well developed. Due to the hard and compact nature of the rocks ground water development prospect in the charnockite is not good. Borewells yield less than 1 lps.

Khondalites: These rocks generally form undulating hilly terrains. Moderately weathered rocks exhibit development of porosity with moderate water yielding capacity. Intensive weathering results in the formation of kaolin reducing permeability. The depth of weathering varies from 5 m to 32 m. The specific capacity of the only tested dug wells ranges from 2.3 to is 13.3 lpm/m drawdown. The yield of borewells is poor and within 1 lps.

Quartzites: These rocks occur as distinct bands and are very resistant to weathering. The weathered mantle is thin and joints are less developed. As such these rocks do not form good aquifers.

Anorthosites: These rocks are generally hard ans massive in nature. Weathering yields white clayey material, which restricts movement of ground water. Joints and foliations are also not well developed and these rocks do not form good aquifers.

Pegmatite and Quartz Veins: These are generally coarse grained and hard. When fractured and friable, they can form good aquifer.

B. Semi Consolidated Formations

The rocks of Lower Gondwana occur in a small patch in the western side of the district in Sonepur block. These rocks have faulted contact with the Precambrians. The friable and loosely connected sandstone form the aquifers. Ground water occurs under water table conditions in the weathered zone and under semi-confined to confined condition in the deeper fractured and friable sandstone beds. The depth of the open dug wells ranges from 5 to 12 mbgl and depth to water level ranges from 3 to 10 mbgl. The yield of the wells in these formations in the district is generally limited.

C. Unconsolidated Formation

They generally comprise of the laterites and alluvium of Sub-recent to Recent age. Laterites occurring as capping over older formations are highly porous in nature and form good aquifers to be tapped through dug wells. The alluvial deposits occur as thin discontinuous patches along the prominent drainage channels. The alluvium varies in thickness from 6 to 12 m. These mainly consist of silt, sand with gravel and pebble, which form potential shallow aquifers tapped through dug wells.

2.3 Ground Water Exploration

In order to decipher the aquifer system of the area, CGWB has constructed 35 Exploratory Wells (EW), 7 Observation Wells (OW) and 4 Piezometers (PZ) under in-house departmental Ground Water Exploration programme, which are shown in **Fig. 2.3** and the data generated has been shown in **Table 2.2**. Apart from them, to mitigate the drinking water scarcity in the drought prone areas, 24 Nos. EWs were drilled under Accelerated Exploratory Drilling Programme (AEDP), Phase-I and II during the year 2001, whose locations are shown in **Fig. 2.4**. The exploration data generated has been given in **Table 2.3**.

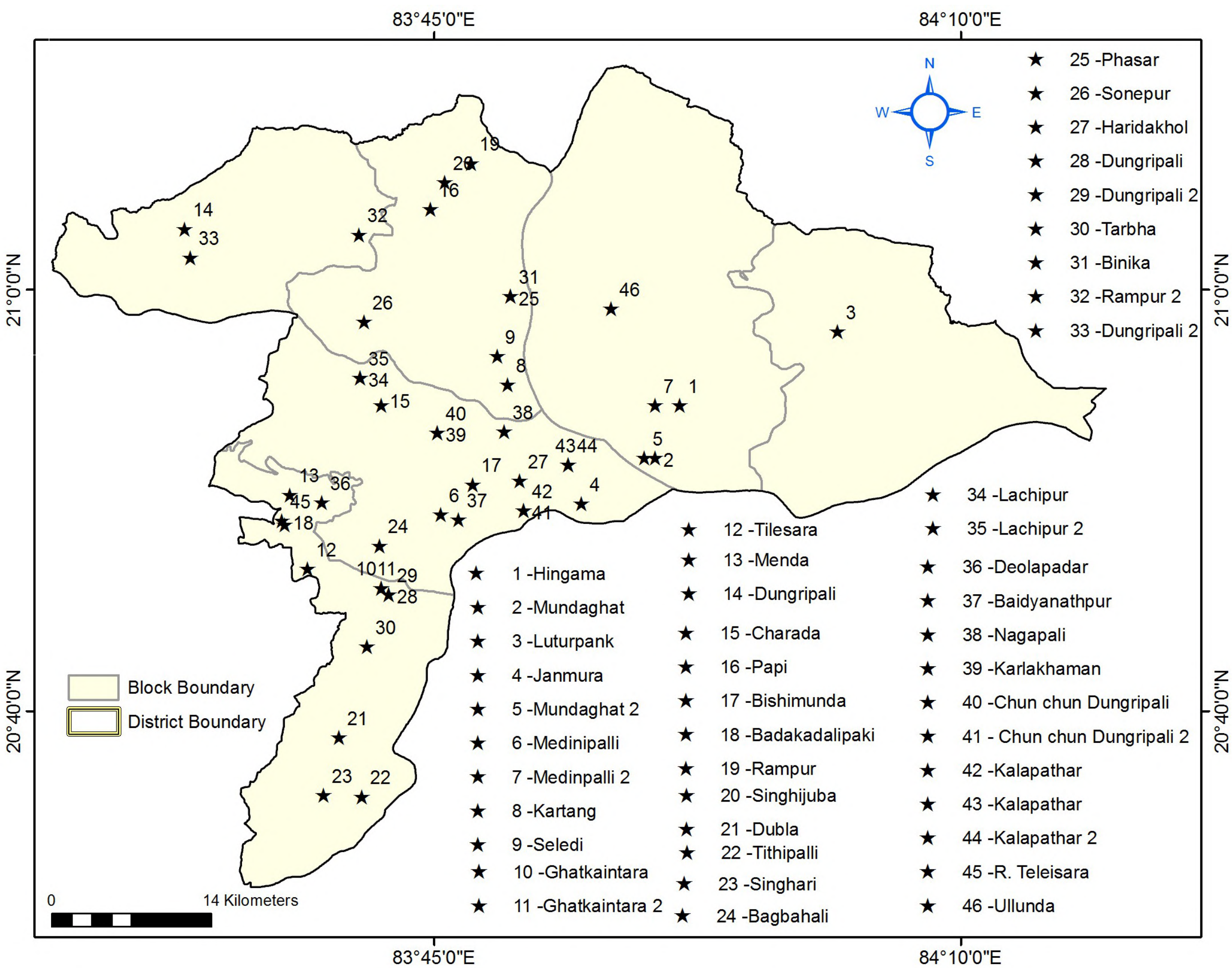


Fig. 2.3: Locations of Exploratory Wells Drilled by CGWB (In-House) in Suvarnapur District.

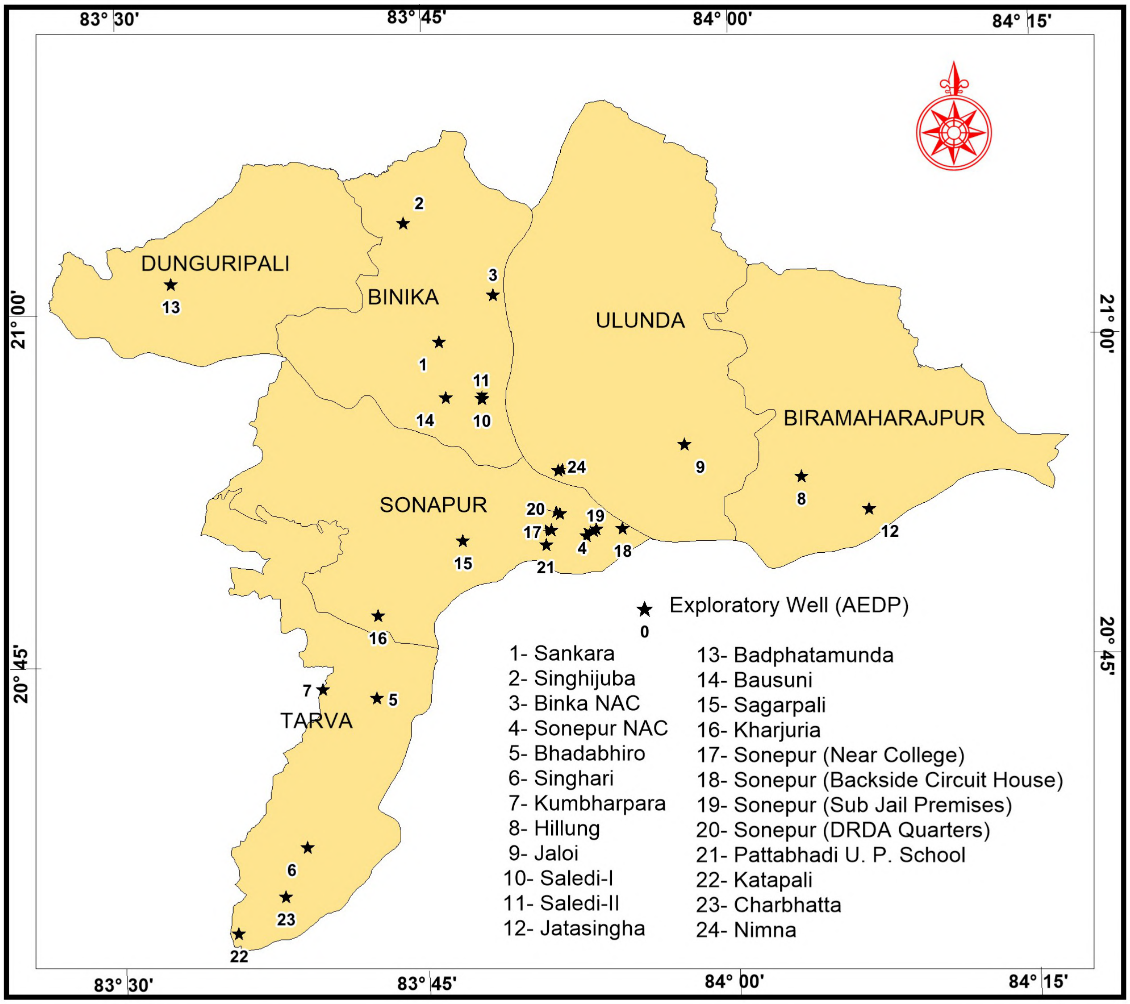


Fig. 2.4: Locations of Exploratory Wells Drilled under AEDP in Suvarnapur District.

2.4 Monitoring of Ground Water Regime

Under NAQUIM, the ground water regime of the phreatic aquifer was monitored during pre- and post-monsoon periods in 2019-20 in 55 National Hydrograph Network Stations (NHNS). The details of the monitoring wells are shown in **Table 2.4** and the locations of the monitoring stations are shown in **Fig. 2.5**. The chemical quality of ground water in the district is monitored annually on a routine basis by CGWB through its NHNSs. The chemical analysis of water samples collected from the 45 National Hydrograph Network Stations (NHNS) during the pre-monsoon season in 2018 given in **Table 2.5.** Quality of ground water from deeper aquifers is assessed during the drilling and pumping tests. The chemical data of 20 water samples collected during the exploration is given in **Table 2.6.**

Table 2.2: Basic Data of Exploratory Wells Drilled by CGWB in Suvarnapur District.

S.No	Location	Type	Latitude	Longitude	Depth Drilled (mbgl)	Lithology	Casing Depth (mbgl)	Aquifer zones tapped (mbgl)	SWL (mbgl)	Disch-arge (lps)	Draw-down (m)	T (m²/day)	S
Block : BINIKA													
1	Binika	EW	20.9947	83.8105	203.30	Gar. Fer. Gr.	12.50	57,90	3.60	0.70			
2	Charada	EW	20.9083	83.7083	179.9	Granite	11.5	32.75-38.60	11.1	0.77			
3	Haridakhol	EW	20.849	83.8177	191.10	Gr. Gneiss	13.50	15,161	3.64	1.00	39.10		
4	Kartang	EW	20.9250	83.8083	185	Granite	17	17.00-18.00	2.1	0.9			
5	Papi	EW	21.0639	83.7472	178.9	Granite	8.5		2.12	0.25			
6	Phasar	EW	20.9947	83.8105	198.28	Sst and shale							
7	Rampur	EW	21.1000	83.7792	148.3	Anorthosite	8.5	50.80-51.80	1.2	0.6			
8	Rampur	OW	21.0435	83.6905	187.00	Gar. Fer. Gr.		187,		NIL			
9	Seledi	EW	20.9472	83.8000	160.6	Granite	18	30.40-32.00	4.3	0.44			
10	Singhijuba	EW	21.0847	83.7583	75.2	Anorthosite	11.5	Dry		Dry			
Block : BIRMAHARAJPUR													
11	Luturpank	EW	20.9667	84.0694	200.2	Granite	18	25.00-26.00	3.95	0.5			
Block : DUNGRIPALI													
12	Dungripali	PZ	21.0481	83.5528	46	Granite	5.6	32.10-33.50,42.00-43.00	5.25	0.5			
13	Dungripali	EW	20.7588	83.714	154.50	Biotite granite	20.30	23,135,	7.32	2.80	35.02		
14	Dungripali	OW	20.7588	83.714	130.10	Biotite granite	15.20	42,107	6.30	1.10	35.50		
15	Dungripali	EW	21.0253	83.5572	197.20	Gar. Fer. Gr. Gneiss		16,18	0.59	2.0	33.65		
Block : SONEPUR													
16	Baidyanathpur	EW	20.818	83.7693	148.40	Granite gneiss	30.50	50,60		0.80			
17	Bagbahali	EW	20.7972	83.7069	148.4	Anorthosite	5.9	28-30	4.74	4.74			
18	Bishimunda	EW	20.8458	83.7806	160.6	Quartzite/Granit	16.5	97.50-101.70	3.34	2.5	28.46	1.8	
19	Chun chun	EW	20.8253	83.821	110.30	Granite gneiss	20.30	21/23,55,110	2.00	14.0	26.0		
20	Chun chun	OW	20.8253	83.821	114.40	Granite gneiss	20.30	114	2.54	10.2	23.5		
21	Deolapadar	EW	20.8314	83.6612	178.90	Granite gneiss		91		0.50			
22	Janmura	EW	20.8306	83.8667	200.2	Granite	15.5	104.00-105.00	2.8	0.5			
23	Kalapathar	EW	20.8615	83.8565	111.30	F.Gr. Gneiss	19.32	20/24,30/32, 41/45, 50/56, 63/65,75/77	5.22	8.5	15.38		

24	Kalapathar	OW	20.8615	83.8565	154.00	F.Gr. Gneiss	19.21	32/33, 39, 42/45,51/55, 63/66, 100/104	4.74	6.3	28.56		
25	Karlakhaman	EW	20.8868	83.7526	94.40	Granite gneiss	16.10			8.5	22.5		
26	Karlakhaman	OW	20.8868	83.7526	99.40	Granite gneiss	12.06			8.5	19.7		
27	Lachipur	EW	20.9302	83.6918	180.00	Granite gneiss		19,83,167,175		10.00	10.74		
28	Lachipur	OW	20.9302	83.6918	178.90	Granite gneiss		110,143,160		5.00	19.68		
29	Medinipalli	EW	20.8222	83.7556	160.6	Granite	9.5	25.00-26.00,93.00-	2.32	3.35			
30	Medinipalli	OW	20.9083	83.9250	154.5	Granite	9.5	11.00-14.00,124.00-127.00	3.52	4.44			
31	Nagapali	EW	20.8877	83.8057	190.60	Granite gneiss	20.35	-		0.20			
32	Sonepur	EW	20.9745	83.6946	185.00	Gr. Gneiss	8.10	46,	10.56	0.20			
Block : TARABHA													
33	Badakadalipaki	EW	20.8139	83.6319	154.5	Quartzite/Anort	11.5	27.40-33.50	4.6	2.8	14.63	2.53	
34	Dubla	EW	20.6458	83.6750	148.4	Anorthosite	11.5	Dry		Dry			
35	Ghatkaintara	EW	20.7639	83.7083	160.6	Granite	20	26.50-28.50,32.60-35.00	3.5	7			
36	Ghatkaintara	EW	20.7639	83.7083	130.1	Granite	18	24.50-25.50,30.00-32.50	4	12.2			
37	Menda	PZ	20.8375	83.6361	63	Granite	12		3.48	0.44			
38	R. Teleisara	EW	20.8169	83.6295	190.60	Anorthosite	17.80	24,26,	5.09	1.0	30.6		
39	Singhari	EW	20.6000	83.6625	148.4	Granite	12	28-30	3.66	3.66	6.34	7.11	
40	Tarbha	EW	20.7175	83.6972	197.20	Anorthosite	10.50			NIL			
41	Tilesara	PZ	20.7792	83.6500	63	Granite	11.5	32.50-38.60,54.00-57.00	5.28	1.9			
42	Tithipalli	EW	20.5986	83.6931	75.2	Granite	12.5	11-16,49-55	5.71	5.71	5.73	56.97	
Block : ULLUNDA													
43	Ullunda	EW	20.9851	83.8901	197.0	Granite	13.76	38,42,64,66,133,136		1.80			
44	Hingama	EW	20.9083	83.9444	172.8	Biotote Granite	23	26.40-32.40,38.40-39.50	6.17	0.6			
45	Mundaghat	EW	20.8667	83.9250	200.2	Granite	5.5	45.60-47.0	4.1	1			
46	Mundaghat	PZ	20.8667	83.9167	63	Granite	8.5	14.50-15.50	5.5	0.5			

Table 2.3: Basic Data of Exploratory Wells Drilled by CGWB under AEDP in Suvarnapur District.

S.No	Location	Block	Type	Latitude	Longitude	Depth Drilled (mbgl)	Casing Depth (mbgl)		Aquifer zones tapped (mbgl)	SWL (mbgl)	Disch-arge (lps)
							Dia 203 mm	Dia 178 mm			
PHASE-I of AEDP											
1	Sankara	Binka	EW	20.9925	83.7667	150.0					2.0
2	Singhijuba	Binka	EW	21.0832	83.7373	150.0					0.5
3	Binka NAC	Binka	EW	21.0283	83.8106	150.0					1.0
4	Sonepur NAC	Sonepur	EW	20.8495	83.8950	150.0					1.0
5	Bhadabhino	Tarbha	EW	20.7200	83.7161	133.0					6.0
6	Singhari	Tarbha	EW	20.6061	83.6594	150.0					2.0
7	Kumbharpada	Tarbha	EW	20.7268	83.6716	150.0					2.0
8	Hillung	Birmaharajpur	EW	20.8901	84.0631	150.0					0.5
9	Jaloi	Ullunda	EW	20.9144	83.9674	138.0					6.0
PHASE-II of AEDP											
10	Saledi-I	Binka	EW	20.9494	83.8014	150.0	40				
11	Saledi-II	Binka	EW	20.9489	83.8019	150.0	7.6	8.2	38.7	15.19	0.5
12	Jatasingha	Birmaharajpur	EW	20.8653	84.1181	150.0	36.1	36.7	46.8, 63.3, 107.3,145.8	7.73	1.2
13	Badphatamunda	Dungripali	EW	21.0361	83.5472	98.9	17.9	18.3	38.4, 131.5	16.95	0.5
14	Bausuni	Sonepur	EW	20.9500	83.7722	84.7	13.42	14.02	38.7, 98.0	5.73	3.0
15	Sagarpali	Sonepur	EW	20.8403	83.7861	150.0	17.7	18.3	26.6, 36.3, 58.0, 84.2	6.41	10.1
16	Kharjuria	Sonepur	EW	20.7833	83.7167	150.0	17.9	18.3	38.4, 131.5	16.95	1.0
17	Sonepur (Near College)	Sonepur	EW	20.8486	83.8583	150.0	11.7	12.2	121, 133	16.5	4.5
18	Sonepur (Backside Circuit House)	Sonepur	EW	20.8500	83.9167	150.0	6.7	7.3	12, 29, 142	12.5	0.8
19	Sonepur (Sub- Jail Premises)	Sonepur	EW	20.8444	83.8875	150.0	19.5	20.1	36.3, 105	27.19	Negl.
20	Sonepur (DRDA Quarters)	Sonepur	EW	20.8611	83.8653	150.0	11.6	12.2	14.5, 45.9, 105.7, 142	7.69	4.5
21	Sonepur (Pattabhadi U.P. School)	Sonepur	EW	20.8375	83.8542	150.0	19.36	19.96	45.3, 55.6, 98.9	14.25	Negl.
22	Katapali	Tarbha	EW	20.5347	83.5861	150.0	9.2	9.8	14.4, 40.8, 60, 69.6	9.82	2.0
23	Charbhatta	Tarbha	EW	20.5681	83.6417	129.5	26.2	26.8	50.4, 86.4, 129	11.55	0.8
24	Nimna	Ullunda	EW	20.8944	83.8639	150.0	17.8	18.3	24.7, 57.8, 112.8	5.96	1.0

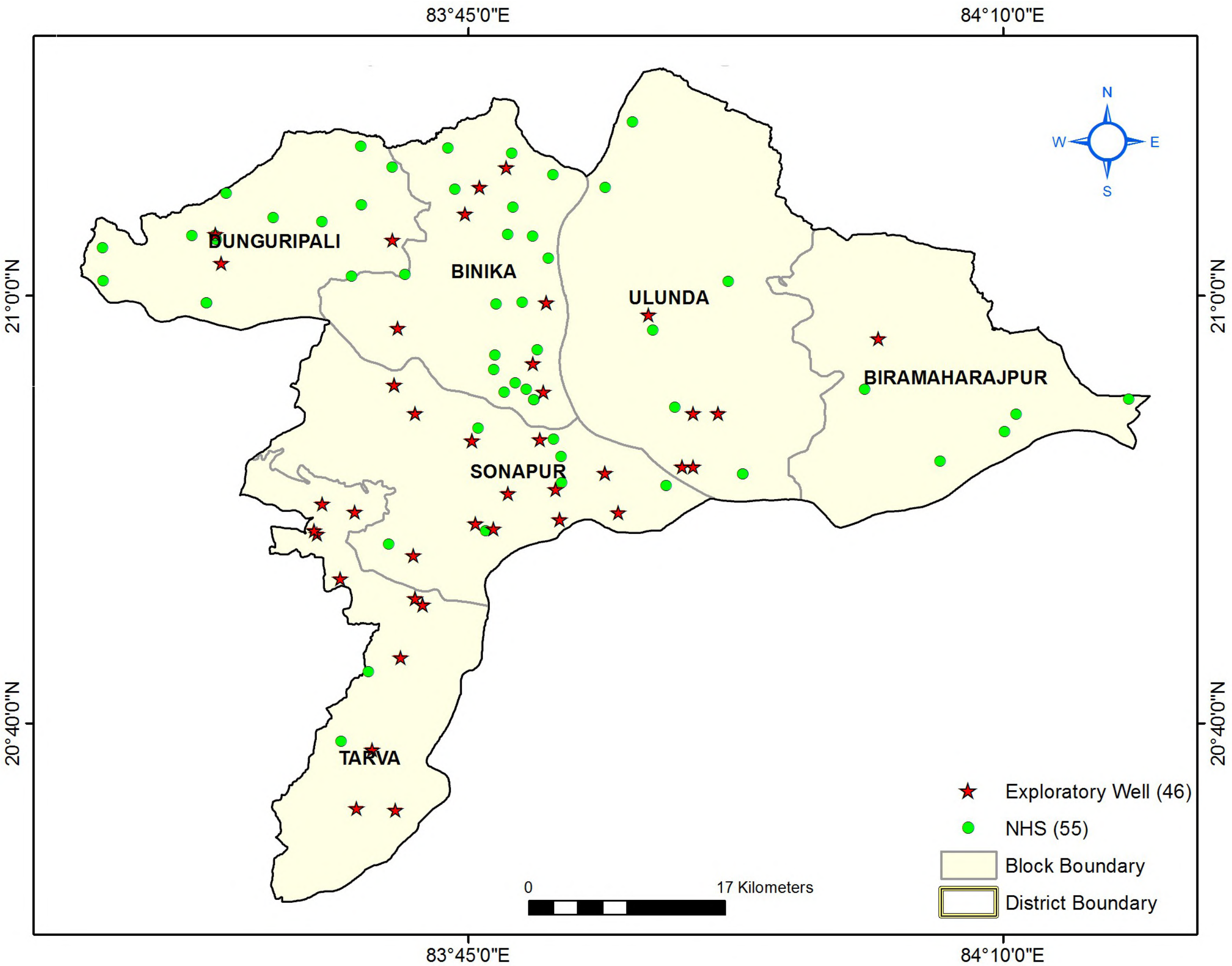


Fig. 2.5: Locations of Ground Water Monitoring Stations in Suvarnapur District.

Table 2.4: Details of Ground Water Monitoring wells in Suvarnapur District (2019).

Sl No	Location	Block	Type	Longitude	Latitude	Elevation (maMSL)	Pre-Monsoon DTWL (mbgl)	Post-Monsoon DTWL (mbgl)
1	Ankhidadar	BINIKA	NHNS	83.8161	21.0944	133.8	7.5	2.75
2	Antarda	BINIKA	NHNS	83.7808	21.0481	136.7	2.18	2.45
3	Arjunpur	SONEPUR	NHNS	83.8228	20.8544	141.2	6.9	3.25
4	Bagdiha	BINIKA	NHNS	83.7342	21.1153	160	2.6	1.95
5	Baghahandi	DUNGURIPALI	NHNS	83.6361	21.0581	156.9	1.72	1.98
6	Bausuni	BINIKA	NHNS	83.7708	20.9536	147.6	5.78	3.43
7	Bhimtikra	DUNGURIPALI	NHNS	83.7008	21.0167	145.1	1	1.99
8	Binika	ULUNDA	NHNS	83.8125	21.0294	128.4	4.03	2.6
9	Biramaharajpur	BIRAMAHARAJPUR	NHNS	84.0589	20.9269	110.1	6.81	2.49
10	Bishalpali	BINIKA	NHNS	83.7847	21.0692	153	4.7	2.95
11	Borumunda	SONEPUR	NHNS	83.7700	20.9425	131	6.55	3.82

12	Charuapali (new)	DUNGURIPALI	NHNS	83.5458	20.9947	151.2	1.8	
13	Danipali	ULUNDA	NHNS	83.8000	21.0467	125	3.3	3.42
14	Dhurakhaman	SONEPUR	NHNS	83.8164	20.8881	124.2	1.84	2.18
15	Gajabandhu	DUNGURIPALI	NHNS	83.6589	21.0153	147.6	0.77	1.88
16	Gambharipalli	DUNGURIPALI	NHNS	83.5347	21.0469	168.1	0.77	1.89
17	Ichhapur1	DUNGURIPALI	NHNS	83.4647	21.0375	163.6	3.35	2.6
18	Jatesingha	BIRAMAHARAJPUR	NHNS	84.1181	20.8708	107.3	6.22	2.15
19	Karlajuri	DUNGURIPALI	NHNS	83.4653	21.0117	151	4.6	1.92
20	Khaliapali	SONEPUR	NHNS	83.7575	20.8969	137.2	6.61	3.62
21	Mahada	ULUNDA	NHNS	83.9642	20.8608	117.9	6.15	2.08
22	Mahadevpali	BINIKA	NHNS	83.7950	20.9272	129.3	7.04	2.13
23	Metakani	ULUNDA	NHNS	83.9642	20.8608	117.9	3.04	1.69
24	Naikpada	ULUNDA	NHNS	83.9111	20.9131	129	6.3	3.33
25	Phulmuthi	ULUNDA	NHNS	83.7922	20.9950	132.4	4.46	3.13
26	Rampur	BINIKA	NHNS	83.6906	21.1006	167	6.65	4.65
27	Sakama	BINIKA	NHNS	83.7781	20.9247	129.1	6.94	4.68
28	Saledi	BINIKA	NHNS	83.8036	20.9578	130	5.78	4.68
29	Samalaichuan	DUNGURIPALI	NHNS	83.5981	21.0611	156.7	2.2	2.45
30	Sankara1	BINIKA	NHNS	83.7717	20.9936	136.9	2.08	1.65
31	Sarangapali	BINIKA	NHNS	83.7839	21.1111	144.1	1.96	2.02
32	Sarasmal	DUNGURIPALI	NHNS	83.6661	21.1167	169	1.78	2.3
33	Sindol	ULUNDA	NHNS	83.8569	21.0847	143.4	3.07	1.31
34	Singhijuba	BINIKA	NHNS	83.7394	21.0833	149.1	1.9	2.35
35	Sonepur	SONEPUR	NHNS	83.9042	20.8522	113.3	7.6	3.54
36	Subalaya	BIRAMAHARAJPUR	NHNS	84.1681	20.8939	102.3	7.57	5.09
37	Tebhapadar	BIRAMAHARAJPUR	NHNS	84.1769	20.9075	98.6	7.13	4.42
38	Ulunda	ULUNDA	NHNS	83.8939	20.9731	140.1	5.9	3.35
39	Nandanamal	SONEPUR	NHNS	83.8222	20.8744	132.5	4.2	
40	Dungripalli	DUNGURIPALI	NHNS	83.5533	21.0439	167.8	1.02	1.05
41	Kotasamalai	ULUNDA	NHNS	83.9528	21.0111	171.8	5.15	3.2
42	Bagduli	SONEPUR	NHNS	83.7633	20.8167	126.1	4.84	2.48
43	Baladi	SONEPUR	NHNS	83.6881	20.8064	145.7	5.84	
44	Palsapadar	TARBHA	NHNS	83.6508	20.6522	152	3.53	1.44
45	Sargaj 1	TARBHA	NHNS	83.6719	20.7069	134.3	6.24	4.88
46	Gariamunda	BIRAMAHARAJPUR	NHNS	84.2650	20.9194	101.3	4.5	
47	Karttanga	BINIKA	NHNS	83.8011	20.9192	130.3	4.6	
48	Sansamura	BINIKA	NHNS	83.7867	20.9319	129.8	6.9	1.23
49	Barkarle	DUNGURIPALI	NHNS	83.6667	21.0708	170		1.98
50	Charuapali (new)	DUNGURIPALI	NHNS	83.5458	20.9947	151.2		1.18
51	Karttanga	BINIKA	NHNS	83.8011	20.9192	130.3		0.95
52	S Patrapali	ULUNDA	NHNS	83.8781	21.1358	130.4		4.55
53	Dunguripalli New	DUNGURIPALI	NHNS	83.5525	21.0469	165		1.02
54	Dunguripalli New	DUNGURIPALI	NHNS	83.5525	21.0469	165		1.05
55	Chandajhuri	DUNGURIPALI	NHNS	83.5611	21.0800	167.4		3.8
						MIN	0.77	0.95
						MAX	7.6	5.09
						AVG	4.45	2.66

Table-2.5: Ground Water Quality Data of Monitoring Wells in Suvarnapur District (2018).

Sl No	Location	Block	Latitude	Longitude	pH	EC	Hardness	Alkalinity	Ca++	Mg	Na+	K+	CO3=	HCO3-	Cl-	SO4=	F-	SAR
						µS/cm	as CaCO3 mg/L		mg/L									
1	Sarasmal	Dunguripali	83.6661	21.1167	7.36	470	134	190	40	8.32	35	4.9	0	232	19	14	0.47	1.32
2	Bagdiha	Binika	83.7342	21.1153	7.36	1030	177	270	58	7.8	125	17	0	329	166.1	9	0.49	4.09
3	Gajabandhu	Dunguripali	83.6589	21.0153	8.17	310	115	120	35	6.58	15	3	0	146	20.1	5	0.53	0.61
4	Rampur	Binika	83.6906	21.1006	8.41	490	172	181	50	11.39	21	4	16	188	30.2	18	0.52	0.7
5	Singhijuba	Binika	83.7394	21.0833	7.15	250	86	79	23	6.96	10	2.6	0	97	28	3	0.33	0.47
6	Binika	Binika	83.8125	21.0294	7.92	520	203	184	64	10.48	21	6	0	225	37.8	7	0.54	0.64
7	Sindol	Ullunda	83.8569	21.0847	7.21	430	150	119	46	8.57	27	4.8	0	145	46	11	0.19	0.96
8	Danipali	Ullunda	83.8000	21.0467	8.41	1140	229	412	67	14.99	125	30	35	432	80.5	41	0.65	3.59
9	Sonepur	Sonepur	83.9042	20.8522	7.12	880	245	280	54	26.81	71	1.2	0	342	74	48	0.62	1.97
10	Phulmuthi	Ullunda	83.7922	20.9950	7.68	1770	547	93	96	74.51	142	20	0	113	468.2	93	0.57	2.64
11	Mahadevpali	Binika	83.7950	20.9272	8.33	500	120	191	42	3.7	48	5	18	197	30.2	10	0.46	1.91
12	Bagduli	Sonepur	83.7633	20.8167	8.23	860	204	343	29	32.01	91	20.5	0	419	40	31	0.71	2.77
13	Arjunpur	Sonepur	83.8228	20.8544	7.28	870	198	254	48	18.93	80	26	0	310	118.3	3	0.68	2.48
14	Palsapadar	Tarbha	83.6508	20.6522	8	730	332	126	47	52.21	12	6.6	0	154	141	53	0.35	0.29
15	Ulunda	Ullunda	83.8939	20.9731	7.24	850	330	220	86	28.06	26	4.7	0	268	139	6	0.3	0.62
16	Antarda	Binika	83.7808	21.0481	8.02	810	177	158	54	10.23	71	34	0	193	133.4	48	0.9	2.32
17	Koiramunda	Binika	83.7500	20.9664	8.09	480	177	100	64	4.16	25	4	0	122	47.8	46	0.62	0.82
18	Subalaya	Birmaharajpur	84.1681	20.8939	7.53	560	230	245	42	30.44	13	0.5	0	299	14	13	0.65	0.37
19	Mahada	Ullunda	83.9642	20.8608	7.93	590	208	96	64	11.75	33	9	0	117	90.6	44	0.57	1
20	Bhimtikra	Dunguripali	83.7008	21.0167	8.37	560	187	231	52	13.97	27	6	16	249	25.2	9	0.53	0.86
21	Barkarle	Dunguripali	83.6667	21.0708	7.65	880	234	166	50	26.56	68	14	0	202	143.5	68	0.68	1.93
22	Samalaichuan	Dunguripali	83.5981	21.0611	8.36	530	187	131	37	23.07	34	3	12	136	52.9	39	0.59	1.08
23	Karlajuri	Dunguripali	83.4653	21.0117	7.92	1460	443	77	156	13	120	16	0	94	349.9	94	0.63	2.48
24	Ankhidadar	Binika	83.8161	21.0944	8.06	1230	198	139	67	7.4	169	31	0	169	231.6	86	**2.5**	5.23
25	Sansamura	Binika	83.7867	20.9319	8.24	430	141	108	48	5.02	31	3	0	132	57.9	21	0.55	1.14
26	Metakani	Ullunda	83.9642	20.8608	7.52	3720	1667	116	173	299.87	76	20	0	141	1064	67	**1.5**	0.81
27	S Patrapali	Ullunda	83.8781	21.1358	8	810	266	120	52	32.93	55	13	0	146	125.8	70	0.47	1.47

28	Khaliapali	Sonepur	83.7575	20.8969	7.94	1040	354	120	106	21.67	66	14	0	146	201.4	64	0.71	1.53
29	Bishalpali	Binika	83.7847	21.0692	8.19	410	130	154	50	1.28	30	2	0	188	30.2	1	0.36	1.14
30	Borumunda	Sonepur	83.7700	20.9425	8.1	430	177	166	60	6.59	15	2	0	202	22.7	1	0.74	0.49
31	Gambharipalli	Dunguripali	83.5347	21.0469	7.81	470	135	120	33	12.85	43	4	0	146	68	1	0.45	1.61
32	Ichhapur1	Dunguripali	83.4647	21.0375	8.26	800	150	131	37	14	105	12	0	160	123.3	54	0.53	3.73
33	Sarangapali	Binika	83.7839	21.1111	8.28	280	109	96	31	7.74	9	6	0	117	20.1	8	0.49	0.37
34	Dhurakhaman	Sonepur	83.8164	20.8881	8.02	470	188	143	44	19	18	4	0	174	37.8	23	0.79	0.57
35	Sakama	Binika	83.7781	20.9247	7.89	1010	344	100	69	41.59	64	17	0	122	201.4	71	0.74	1.5
36	Bausuni	Binika	83.7708	20.9536	8.03	820	271	111	48	36.63	53	15	0	136	163.6	46	0.47	1.4
37	Baghahandi	Dunguripali	83.6361	21.0581	7.72	1200	401	150	44	70.66	82	11	0	183	213.9	84	0.81	1.78
38	Saledi	Binika	83.8036	20.9578	8.14	890	312	93	56	41.89	51	17	0	113	181.2	54	0.38	1.26
39	Karttanga	Binika	83.8011	20.9192	8.16	270	109	84	29	8.96	10	2	0	103	17.6	12	0.72	0.42
40	Naikpada	Ullunda	83.9111	20.9131	8.34	500	151	136	42	11.19	34	3	12	141	55.4	31	0.63	1.2
41	Gariamunda	Birmaharajpur	84.2650	20.9194	7.71	1200	344	89	98	23.99	108	13	0	108	284.4	77	0.52	2.54
42	Tebhapadar	Birmaharajpur	84.1769	20.9075	7.05	1530	735	233	192	61.99	42	1.6	0	284	301	92	0.3	0.67
43	Jatesingha	Birmaharajpur	84.1181	20.8708	7.37	980	219	197	67	12.46	93	20	0	240	201.4	6	0.57	2.74
44	Nandanamal	Sonepur	83.8222	20.8744	7.48	1540	529	396	129	50.12	76	3.3	0	483	241	27	0.86	1.44
45	Kotasamalai	Ullunda	83.9528	21.0111	7.52	370	149	160	48	7.11	9	1.9	0	195	10	7	0.31	0.32
				MIN	**7.05**	**250**	**86**	**77**	**23**	**1.28**	**9**	**0.5**	**0**	**94**	**10**	**1**	**0.19**	**0.29**
				MAX	**8.41**	**3720**	**1667**	**412**	**192**	**299.87**	**169**	**34**	**35**	**483**	**1064**	**94**	**2.5**	**5.23**

Table-2.6: Ground Water Quality Data of Exploratory Wells in Suvarnapur District.

Sl No	Location	Block	Longitude dd-mm-ss	Latitude dd-mm-ss	pH	EC	TDS	Hardness	Ca++	Mg	Na+	K+	CO3=	HCO3-	Cl-	SO4=	NO_3^-	F -	Fe	SAR
						µS/cm	mg/L	as CaCO3 mg/L	mg/L											
1	Badakadali Palli	Tarbha	83-37-55	20-48-50	7.75	490	254	155	34	17	46	1.21		250	24.82	0	6.12	0.8		1.6
2	Baidyanath	Sonepur	83-47-28	20-48-49	7.39	592	362	100	24	9.7	93	2.7		287	21	38	0.5	0.51	3	4.0
3	Bishimunda	Sonepur	83-46-50	20-50-45	7.92	480	240	145	28	18	52	1.3		232	24.8			1.4		1.9
4	Chun Chun Dungripali	Sonepur	83-52-41	20-49-48	8.39	327	196	65	24	1.2	55	0.8	3	162	25	9.8	0.66	**1.6**	0	3.0
5	Ghatkaintara	Tarbha	83-42-30	20-45-50	8.14	480	225	205	36	27.95	13.4	1.8		122	85.2			0.32		0.4
6	Hingma (Budhiapalli)	Ullunda	83-56-40	20-54-30	8.04	620	293	270	40	41.31	19	0.6		341.6	14.2	7.2		0.94		0.5
7	Janmura	Sonepur	83-52-40	20-49-50	7.63	510	246	155	16	27.95	42.4	1.3		262.3	17.8	9.8		0.68		1.5
8	Kalapathar	Sonepur	83.52-06	21-51-35	8.45	363	218	155	44	11	29	1.2	9	226	11	1.7	1.7	0.39	0.21	1.0
9	Karlakhaman	Sonepur	83-45-43	20-52-08	9.05	499	300	203	14	41	47	4.7	30	275	7.1	3.3	1.03	**1.7**		1.4
10	Katrang	Binika	83-48-00	20-55-30	7.79	590	280	185	28	27.95	36.9	2.1		256.2	32	25.15		0.93		1.2
11	Lachhipur	Sonepur	83-41-05	20-55-55	8.09	269	258	145	39	12	9.2	2.3		171	8.9	1.2	12	0.66	8.5	0.3
12	Luturpank	BMpur	84-04-10	20-58-00	8.21	590	280	250	32	41.31	19.2	1.7		262.3	35.5	18.8		0.97		0.5
13	Medininipali	Sonepur	83-45-20	20-49-20	7.34	900	318	225	46	26.7	57.3	1.7		152.5	110			1.05		1.7
14	Menda	Tarbha	83-38-10	20-50-15	7.64	990	500	425	48	74.12	32.1	1.3		189.1	195	55.21		0.4		0.7
15	Mundaghat	Ullunda	83-55-30	20-52-00	7.9	170	112	85	18	9.7	8.6	1.6		91.5	21.3	6.6		0.24		0.4
16	Rampur	Binika	83-46-45	21-06-00	7.6	720	348	260	40	39	50	4.3		378	14.2	11		1.0		1.3
17	Rangpur-Tileisara	Sonepur	83-39-34	20-47-36	7.7	476	286	200	38	26	29	3.3		305	11	3.8	4.1	0.42		0.9
18	Singhari	Tarbha	83-39-45	20-36-00	7.88	580	281	240	34	37.7	24	0		342	11	3		**1.52**		0.7
19	Tilesara	Tarbha	83-39-00	20-46-45	7.75	600	339	195	26	31.59	61.8	1.3		256.2	67.5	22.8		0.63		1.9
20	Tithipali	Tarbha	83-41-35	20-35-55	7.54	450	245	175	34	37.7	24	0		262	18			**1.62**		0.7
				MIN	**7.34**	**170**	**112**	**65**	**14**	**1.2**	**8.6**	**0.0**	**0**	**91.5**	**7.1**	**0.0**	**0.0**	**0.24**	**0.0**	**0.3**
				MAX	**9.05**	**990**	**500**	**425**	**48**	**74.12**	**93**	**4.7**	**30**	**378**	**195**	**55.21**	**12**	**1.7**	**8.5**	**4.0**

3 DATA INTEGRATION, INTERPRETATION AND AQUIFER MAPPING

3.1 Shallow Aquifer

Ground water occurs in phreatic condition in shallow aquifers and is utilized by means of dug wells or shallow tube wells. The depth of the dug wells used as observation points vary from 4.5 to 11 mbgl and their diameter ranges from 0.8 m to 4.60 m. The wells are generally lined to the total depth.

3.1.1 Pre-monsoon Depth to Water Level

Depth to water level in pre-monsoon period (April 2019) varies from 0.77 mbgl (Gajabandhu, Gambharipalli in Dunguripali block) to 7.6 mbgl (Sonepur), the average being 4.45 m bgl. In general the study area has the depth to water level in between 4 to 6 mbgl during the pre-monsoon. Water logging condition (<3 mbgl) is found in small patches in Dunguripalli block. Generally the depth to water level is shallow in western part of the district and within 4 mbgl covering Dunguripali and parts of Binika block and the same gradually becomes deeper eastward and southward i.e east of Mahanadi and towards Tel river. Deepest post- monsoon water levels of 6-8 mbgl are also found as patches in the central part of the district near the boundary of Binika and Ullunda blocks with Sonepur block and also in the eastern-most part of the district in the Birmaharajpur block. The shallow water table in Dunguripalli and Binika block is because of being the tail end section of Hirakud command area with water logging condition in some villages. The pre-monsoon depth to water level map is shown in **Fig. 3.1**.

3.1.2 Post-monsoon Depth to Water Level

Depth to water level in post-monsoon period (Nov 2019) varies from 0.95 mbgl (Karttanga in Binika block) to 5.09 (Subalaya in Birmaharajpur block) mbgl, the average being 2.66 mbgl. The depth to water level of the study area during Nov 2019 is in general within 2-4 mbgl. Deeper water level of 4-6 mbgl is observed in small patch covering Subalaya and Tebhapadar in the eastern part of Birmaharajpur block and at Rampur, Sakma and Saledi in Binika block and Sargaj in Tarabha block. It has been observed that 8 out of total 15 NHNS stations show less than 3 mbgl throughout the year, indicating clearly the instance of water logging condition existing in the area due to the application of excess irrigation water. The post-monsoon depth to water level map is shown below in **Fig. 3.2**.

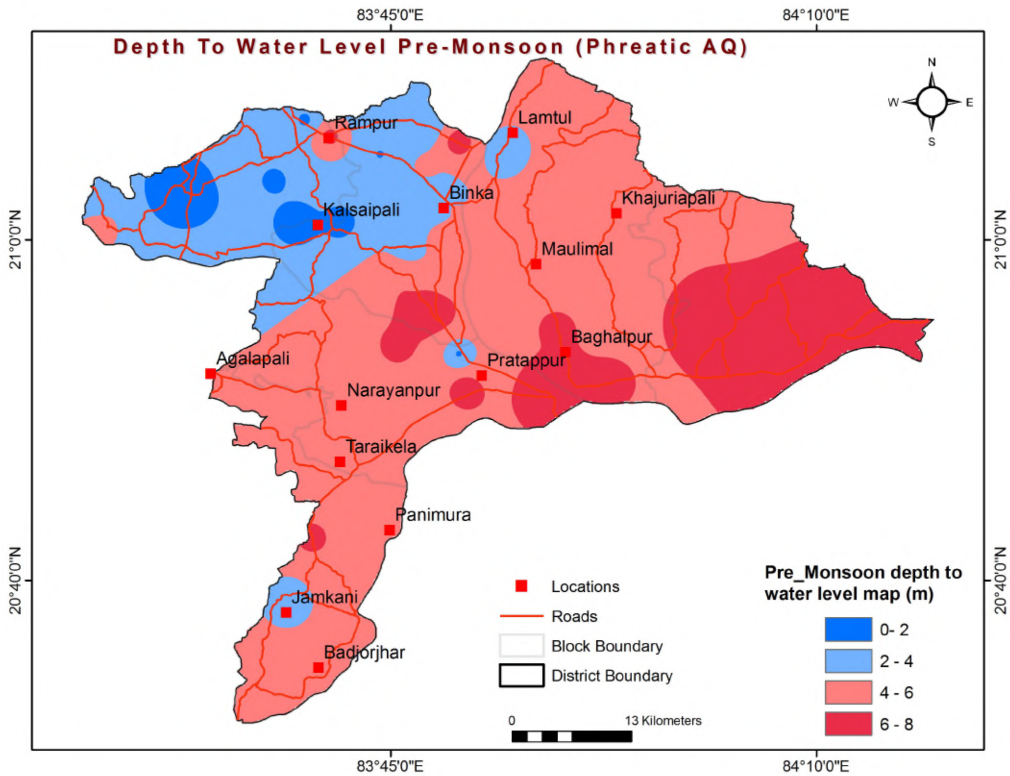


Fig. 3.1: Depth to Water Level in Phreatic Aquifer During Pre-Monsoon.

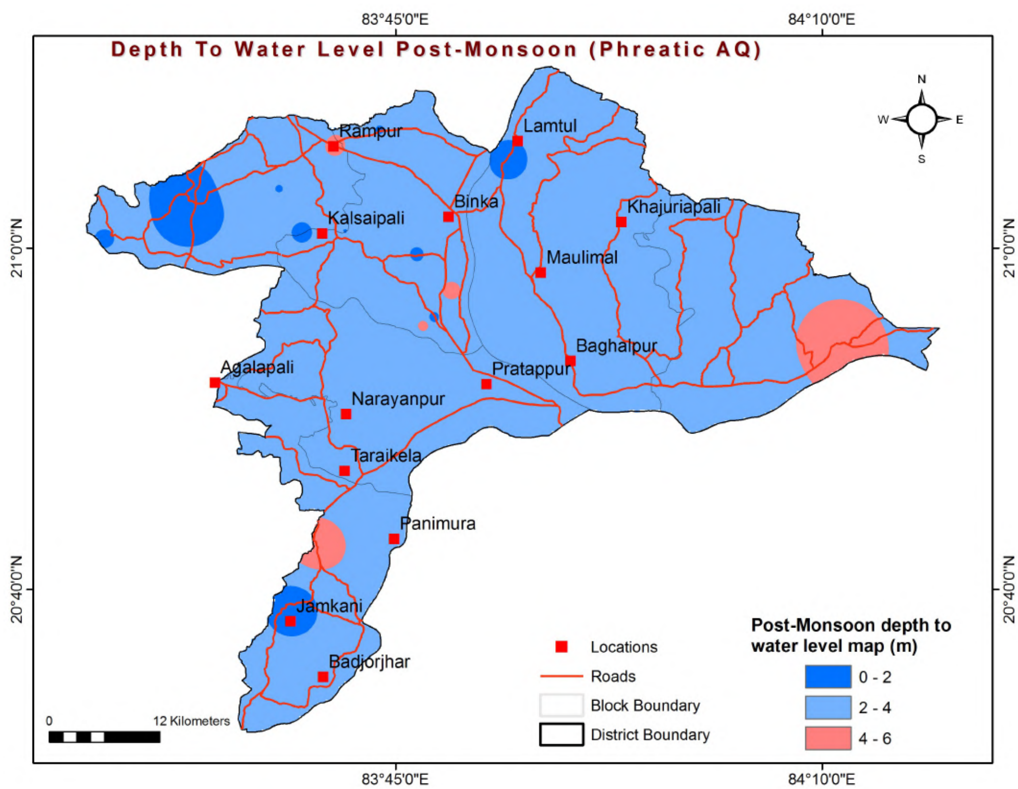


Fig. 3.2: Depth to Water Level in Phreatic Aquifer During Post-Monsoon.

3.1.3 Seasonal Fluctuation of Water Level

The seasonal fluctuation of water level of Aquifer-I is shown in **Fig. 3.3**. Fluctuation of ground water table between pre and post monsoon periods in the study area varies from -1.12 m (Gambharipali in Dungripali block) to 5.67 m (Sansamura in Binika block). Out of 37 stations, 12 stations show fall in water level and 25 stations show rise in water level. The fall in water level during post-monsoon is mostly in the stations within Dungripali block indicating that the effect of rainfall recharge is shadowed in the command area under water logging condition. The rise of water level due to the monsoon rainfall recharge in the 25 stations ranges between 0.43 m (Sankara in Binika block) and 5.67m (Sansamura in Binika block) with average water level rise of 2.78 m. The general range of fluctuation in water level in the study area is between 0-4m. The eastern parts of the district which show relatively deeper water level also show higher fluctuation which indicates good recharge potential of the aquifers. Wherever, the net recharge is inadequate results in deeper post-monsoon water table.

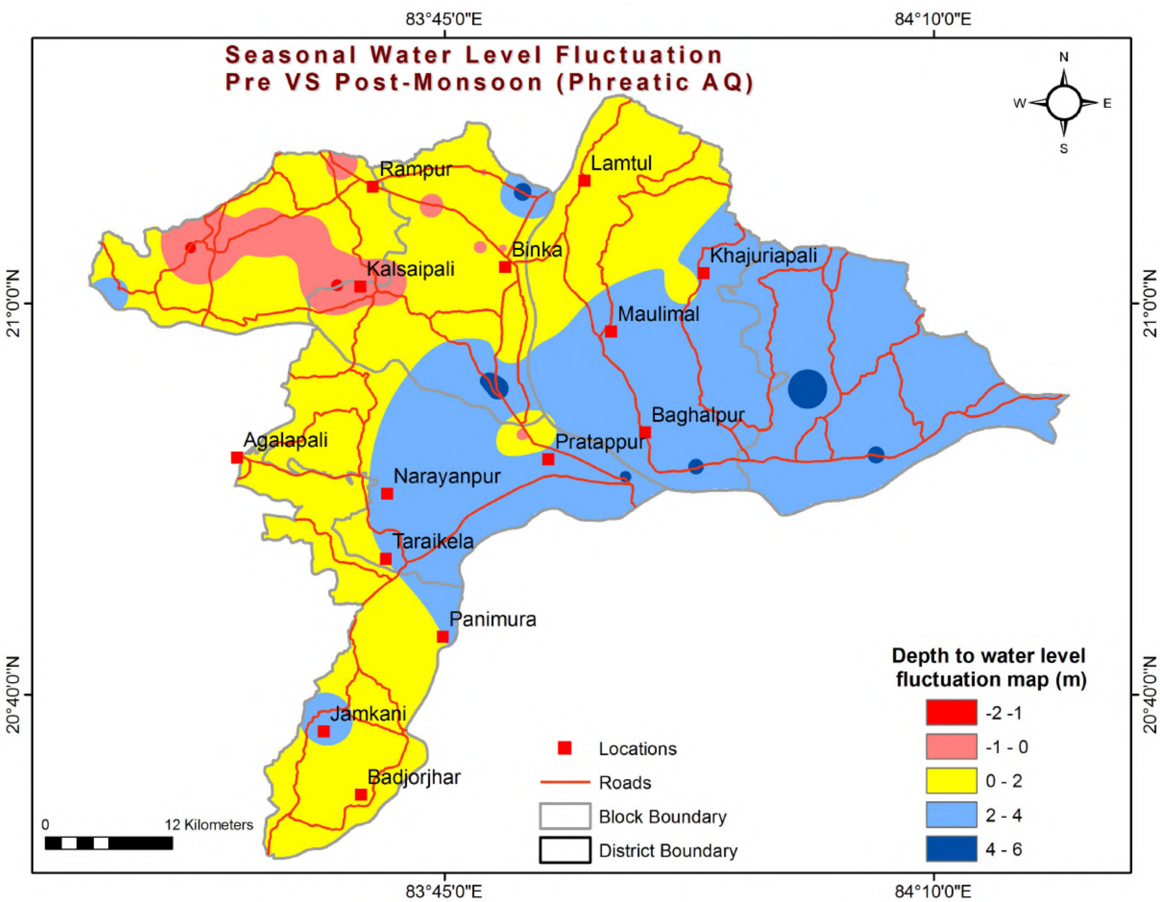


Fig. 3.3: Seasonal Fluctuation in Water Level in Phreatic Aquifer.

3.1.4 Decadal Water Level Trend

There are 55 National Hydrograph Station (NHS) in the district, the data 33 stations having long term data available were considered for analysis of decadal trend for the period 2010-2019. The decadal trend of water level for both pre-monsoon and post-monsoon periods has been analysed and the results shown in **Table-3.1**.

Table-3.1: Analysis of Decadal Water Level Trend (2010-2019) in Suvarnapur District.

Block	Location	Pre-monsoon		Post-monsoon	
		Trend (m/Yr)	Remark	Trend (m/Yr)	Remark
Binika	Sankara1	-0.1588	**Fall**	-0.0589	**Fall**
Binika	Bishalpali	-0.1524	**Fall**	-0.0059	**Fall**
Binika	Sansamura	-0.5182	**Fall**	-0.0510	**Fall**
Binika	Ankhidadar	-0.4492	**Fall**	-0.1204	**Fall**
Binika	Antarda	-0.0662	**Fall**	-0.1320	**Fall**
Binika	Mahadevpali	-0.1455	**Fall**	0.0005	Rise
Binika	Binika	0.0895	Rise	0.0309	Rise
Binika	Sanghijuba	0.0238	Rise	-0.0039	**Fall**
Binika	Rampur	-0.3050	**Fall**	-0.4390	**Fall**
Binika	Bagdiha	-0.0398	**Fall**	-0.0647	**Fall**
Birmaharajpur	Birmaharajpur	0.0187	Rise	0.2560	Rise
Birmaharajpur	Subalaya	-0.0553	**Fall**	-0.0884	**Fall**
Dungripali	Gambharipalli	-0.0645	**Fall**	-0.0969	**Fall**
Dungripali	Karlajuri	0.1816	Rise	-0.0408	**Fall**
Dungripali	Samlaichuan	-0.0225	**Fall**	-0.0655	**Fall**
Dungripali	Barkarle	-0.0727	**Fall**	-0.1253	**Fall**
Dungripali	Bhimtikra	-0.0081	**Fall**	-0.1214	**Fall**
Dungripali	Charuapali	0.1179	Rise	0.0169	Rise
Dungripali	Gajabandhu	0.3092	Rise	0.0676	Rise
Dungripali	Sarasmal	0.2231	Rise	-0.0009	**Fall**
Sonepur	Khaliapalli	0.2748	Rise	0.1005	Rise
Sonepur	Arjunpur	-0.0042	**Fall**	0.1508	Rise
Sonepur	Bagduli	-0.0048	**Fall**	0.1538	Rise
Sonepur	Sonepur	0.0292	Rise	0.1282	Rise
Tarbha	Khari	-0.0787	**Fall**	-0.1488	**Fall**
Tarbha	Palsapadar	0.0288	Rise	-0.0136	**Fall**
Ullunda	Danipali	-0.0646	**Fall**	-0.0908	**Fall**
Ullunda	Jhamchhapar	0.0308	Rise	0.2221	Rise
Ullunda	Metakani	0.0989	Rise	-0.1556	**Fall**
Ullunda	Mahada	-0.0831	**Fall**	-0.1232	**Fall**
Ullunda	Phulmuthi	-0.0328	**Fall**	-0.0026	**Fall**
Ullunda	Sindol	0.0839	Rise	0.0189	Rise
Ullunda	Ullunda	0.0370	Rise	0.0893	Rise
Total	**32**	**-0.5182**	**Rise-14** **Fall-18**		**Rise-12** **Fall-20**

The long term trend analysis indicates that out of 32 stations, during the pre-monsoon 14 (43.75%) show rising trend and the rest 18 stations (56.25%) show falling trend. Similarly during the post-monsoon, 12 (37.5%) show rising trend and the rest 20 stations (62.5%) show falling trend. During the pre-monsoon, the range of fall is from -0.0042 to -0.5182 m/yr, whereas the range of rising trend is from 0.0186 to 0.3092 m/yr. Similarly during the post-monsoon, the range of fall is from -0.0009 to -0.1556 m/yr and the range of rise is from +0.0005 to +0.2560 m/yr. The pre- and post-monsoon decadal trend maps for the period 2010-2019 in the district are shown in **Fig. 3.4** and **Fig. 3.5**.

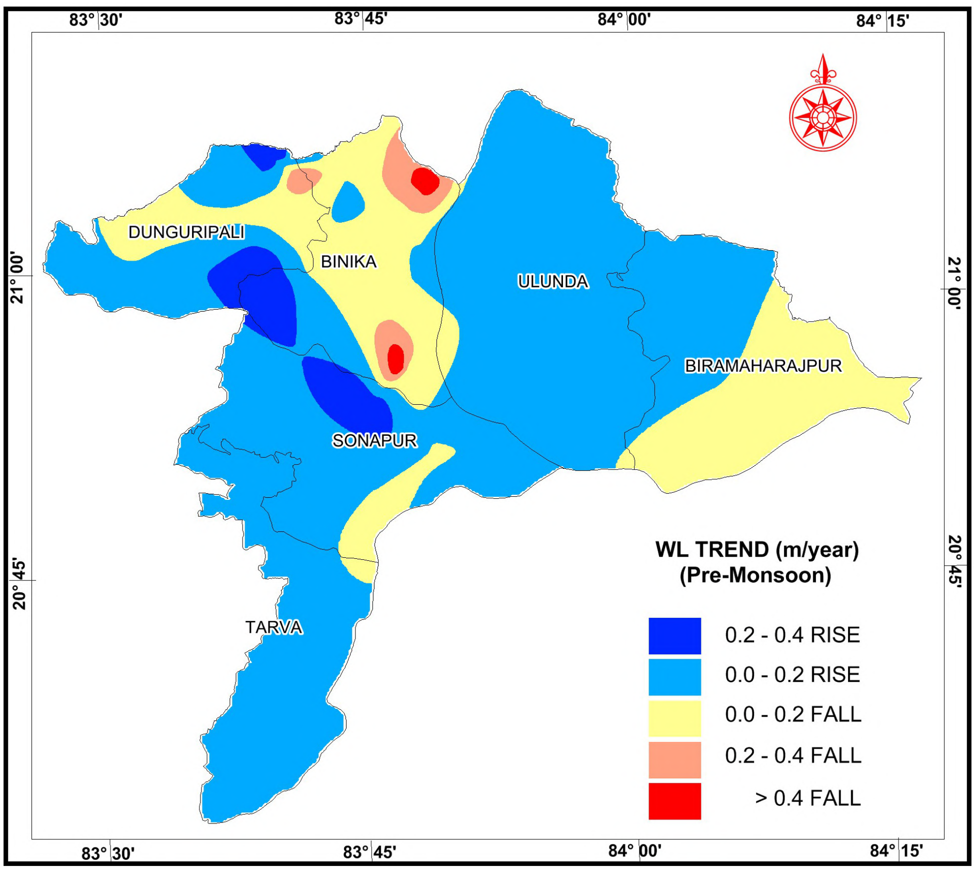


Fig. 3.4: Decadal Trend of Water Level for Pre-Monsoon Period (2010-19), in Suvarnapur District.

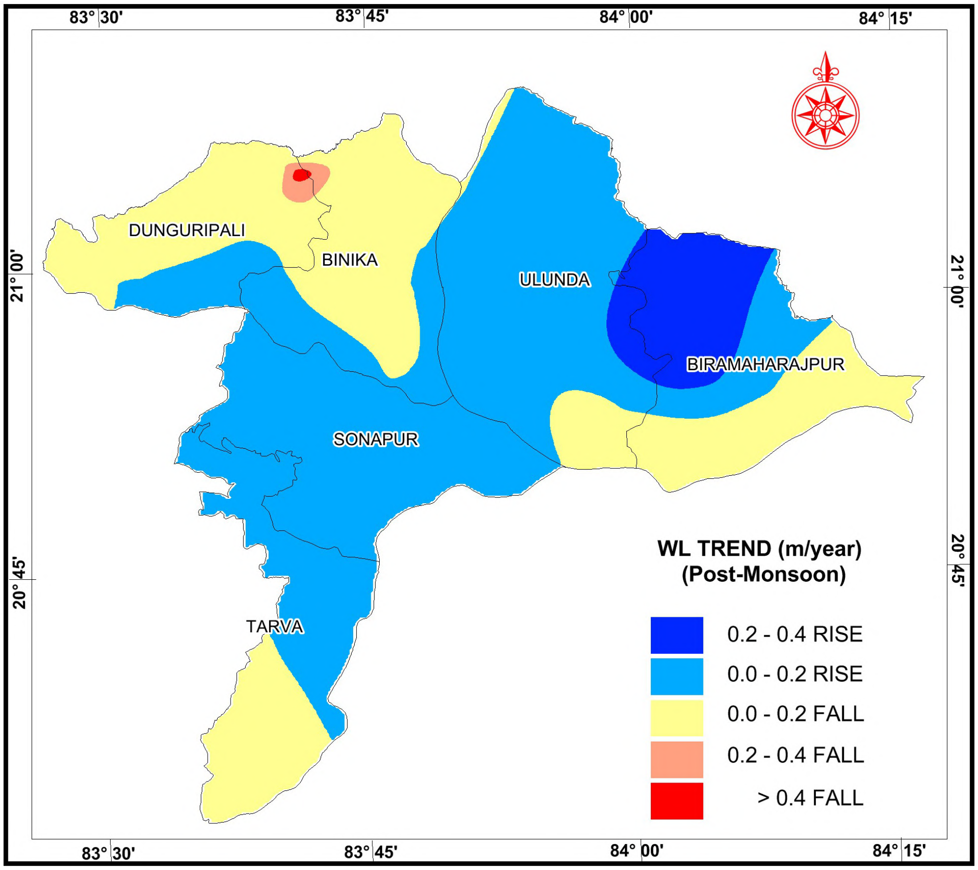


Fig. 3.5: Decadal Trend of Water Level for Post-Monsoon Period (2010-19), in Suvarnapur District.

3.1.5 Hydrograph Analysis

The hydrographs of 9 ground water monitoring stations, were analysed for the period from 2010 to 2019. The variation in short term and long-term water level trends may be due to variation in natural recharge due to rainfall and withdrawal of groundwater for various agricultural activity, domestic requirement and mining & industrial needs.

The water level hydrographs of selected National Hydrograph Network Stations (NHNS) are shown in **Fig. 3.6a** through **3.6i**. An annual rising limb in hydrographs, indicate the natural recharge of groundwater regime due to monsoon rainfall, as the monsoon rainfall is the only source of water. However, the groundwater draft continuously increases as indicated by the recessionary limb. The groundwater resources where not replenished / recharged fully, the groundwater levels come under continuous stress and deplete. It has also been observed that there were few years when the recharge exceeded draft for a particular period or year but in the next successive year, the draft again exceeded recharge.

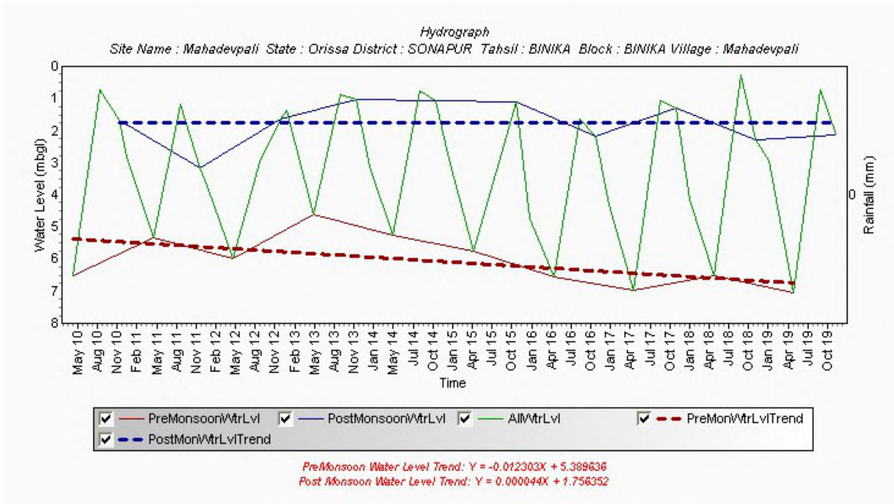


Fig. 3.6a: Hydrograph (2010-19), Mahadevpali, Binika Block.

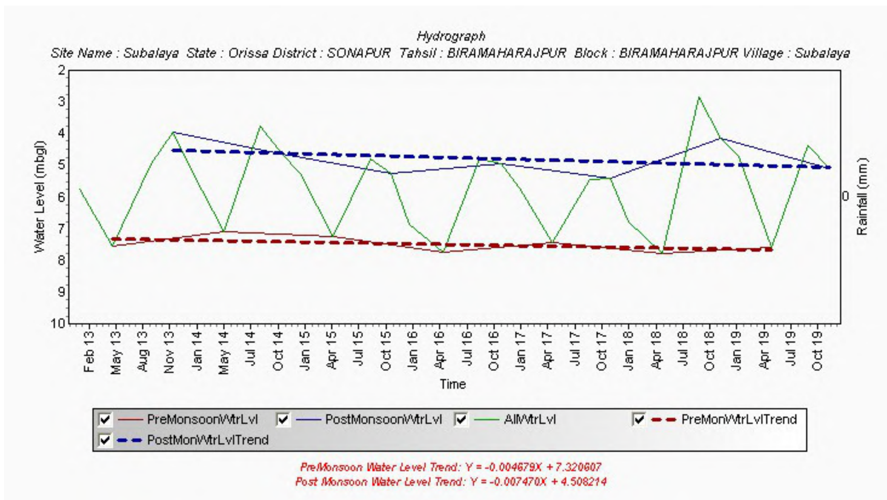


Fig. 3.6b: Hydrograph (2010-19), Subalaya, Birmaharajpur Block.

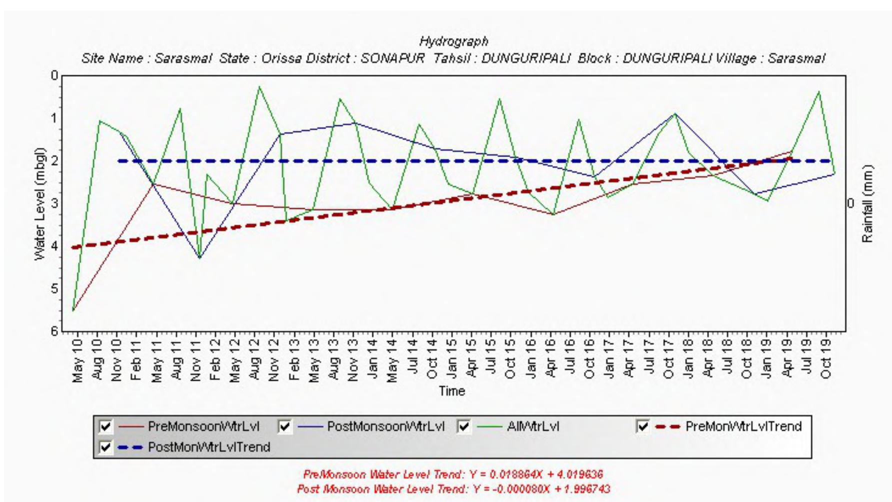


Fig. 3.6c: Hydrograph (2010-19), Sarasmal, Dunguripali Block.

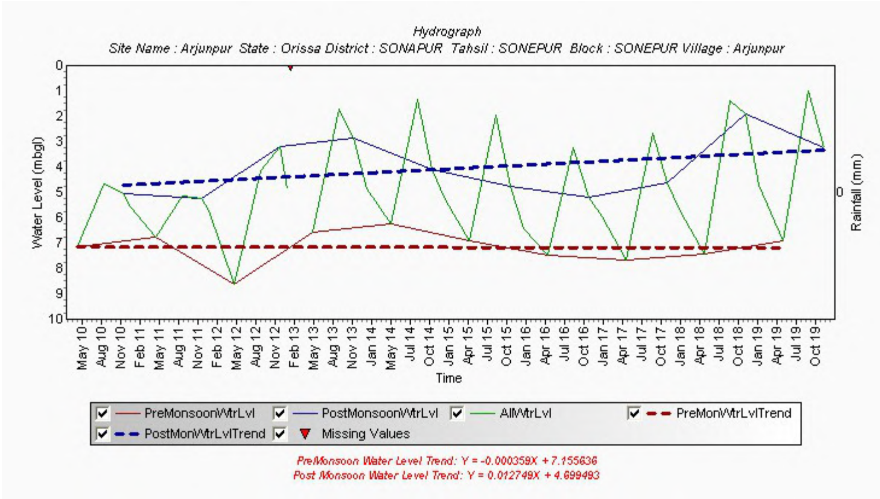


Fig. 3.6d: Hydrograph (2010-19), Arjunpur, Sonepur Block.

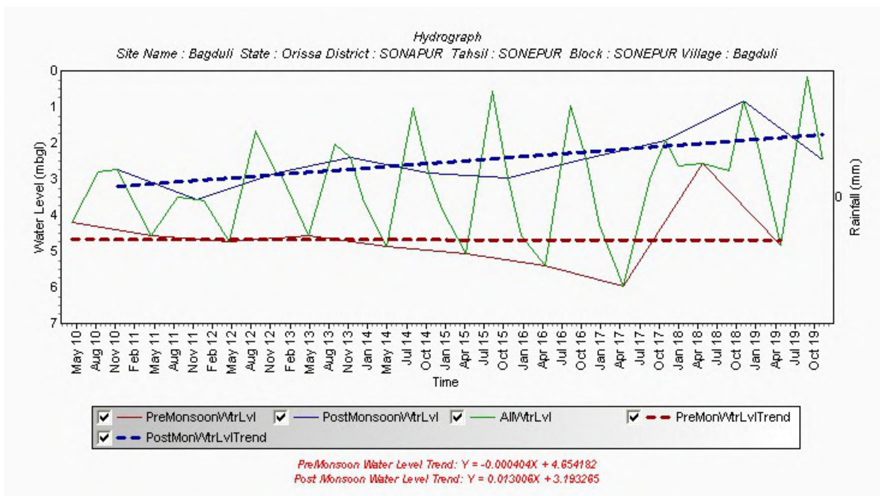


Fig. 3.6e: Hydrograph (2010-19), Bagduli, Sonepur Block.

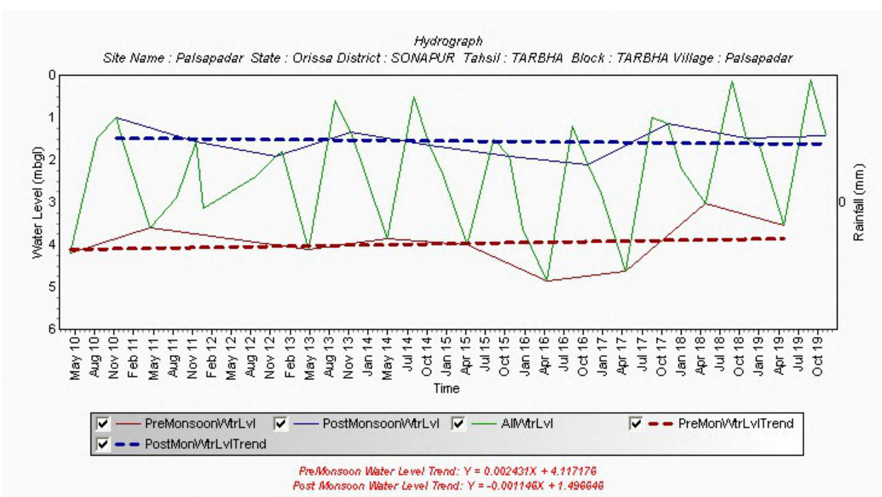


Fig. 3.6f: Hydrograph (2010-19), Palsapadar, Sonepur Block.

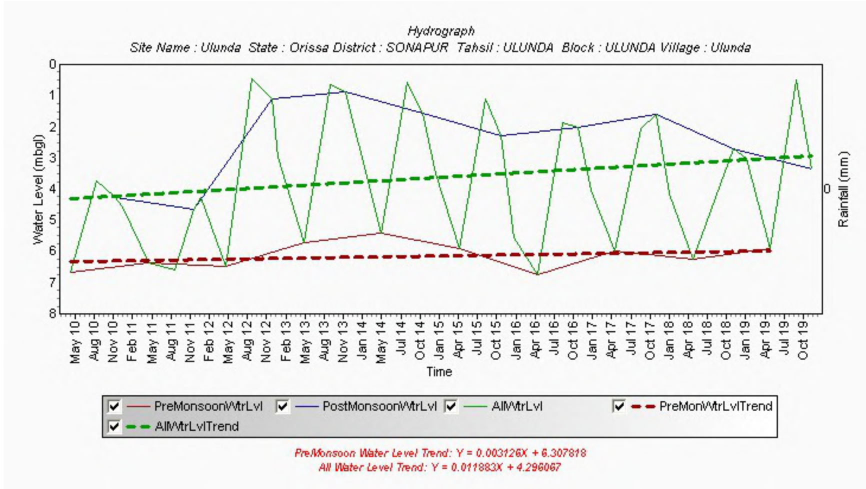


Fig. 3.6g: Hydrograph (2010-19), Ullunda, Ullunda Block.

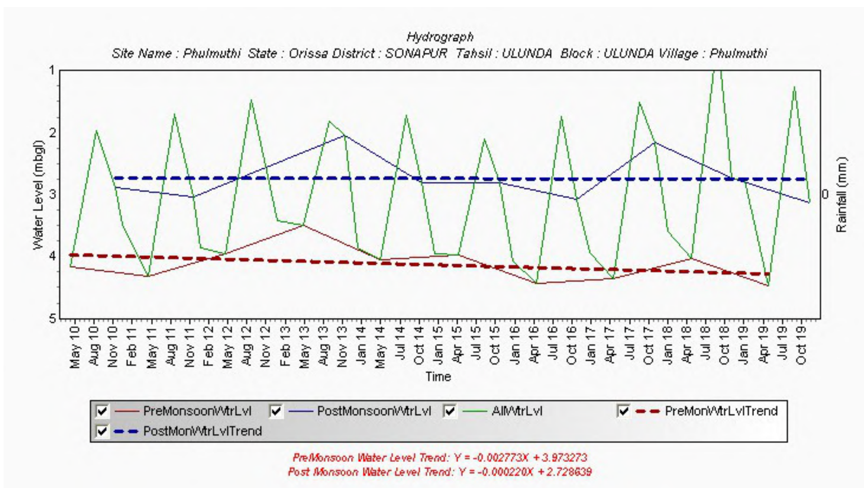


Fig. 3.6h: Hydrograph (2010-19), Phulmuthi, Ullunda Block.

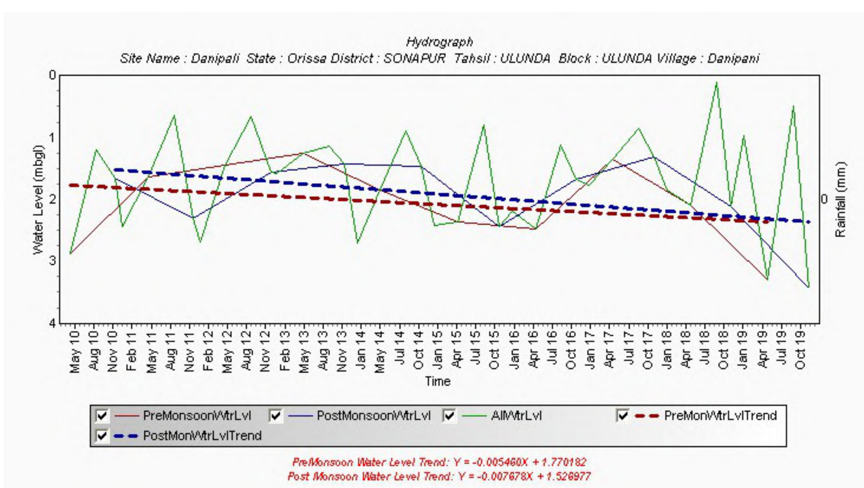


Fig. 3.6i: Hydrograph (2010-19), Danipani, Ullunda Block.

3.1.6 Aquifer Characteristics of Phreatic Aquifer

The aquifer characteristics of phreatic aquifer has been determined on the basis of previous pumping tests carried out on selected dugwells representing different hydrogeological units and the aquifer characteristics was evaluated in terms of Specific Capacity Index i.e. flow of ground water per metre depression of head over unit cross sectional area of inflow offered by the aquifer. The **Table-3.2** summarises the aquifer characteristics of phreatic aquifers. The wide range of yield and specific capacity is due to very much heterogeneous nature of the weathered zone in lateral extension as well as variation of thickness of this zone.

Table-3.2: Aquifer Characteristics of Major Hydrogeological Units in Suvarnapur District.

Sl. No	Hydrogeological Unit	Specific Capacity Index (lpm/m drawdown)
1	Weathered Granite Gneiss	6 to286
2	Weathered Charnockite	1 to 3
3	Khondalites	2.3 to 13.3
4	Lower Gondwana (Sandstone)	2.3
5	Valley Fills	3.0 to 40.0
6	Alluvium	4 to 9

3.2 Deeper Aquifer

Unlike phreatic aquifer, ground water occurs under confined to semi-confined condition in deeper aquifer. The deeper aquifer comprises of the jointed and fractured consolidated or crystalline formations as well as the semi-consolidated formations such as Gondwanas.

CGWB has constructed 79 EWs (Exploratory Well), 7 OWs (Observation Wells) and 4 PZs (Piezometer) in Suvarnapur district through its Ground Water Exploration Programme and AEDP programme, whose depths range from 46.0 m bgl (Dungripali) to 203.3 m bgl (Binika). The static water level varies from 0.5 m bgl (Dungripali) to 27.19 m bgl (Sonepur Jail). The discharge of successful borewells varies from 0.20 lps (Sonepur) to a maximum of 14 lps (Chun Chun Dungripali). The maximum drawdown recorded during PYT/APT varies from 5.73 m (Tithipali) to 39.10 m (Haridakhol). The transmissivity (T) of the aquifers ranges from 1.85 m^2/day (Bishimunda) to 56.97 m^2/day (Tithipali). The details of the exploratory wells are given in **Table-2.2.** Generally 1 to 4 potential fracture zones are encountered within the depth range of 200 m. The first promising zone occurs in the depth range of 15 to 50 m, which is just below the zone of weathering. The second depth range of prime importance is from 70 to 110 m. Normally, the fracture zones in this depth range of 15.0 to 40.0 have high water yielding capabilities and majority of successful bore wells in the study area tapped zones within this depth range. The other potential fracture zones are found at the depth ranges of 40-60, 70-110, 115-145 and 160-190 mbgl. Granite suites rocks have better yield prospect in comparison to other rocks like charnockites, khondalites and anorthosites. However the success of bore wells is site specific and depends on topographic and hydrogeological conditions.

3.3 Ground Water Quality

The chemical quality of ground water in the district is monitored annually on a routine basis by CGWB through its national Hydrograph Network Stations. Quality of ground water from deeper aquifers was assessed during the exploration activities like drilling and pumping tests. The suitability of ground water for drinking/irrigation/industrial purposes is determined keeping in view the effects of various chemical constituents present in water.

Taking the results of chemical analysis during NAQUIM work and the available historical chemical data, the aquifer wise ranges of different chemical constituents present in ground water, are determined and shown in **Table 3.3.**

Table 3.3: Aquifer-Wise Ranges of Chemical Constituents in Suvarnapur District.

Parameter	Unit	Shallow (Aquifer-I)		Deep (Aquifer-II)	
		Minimum	Maximum	Minimum	Maximum
pH	-	7.05	8.4	7.34	9.05
EC	µS/cm	250	3720	170	990
TDS	mg/L	122	1770	112	500
TH	mg/L	86	1667	65	425
TA	mg/L	77	412	75	310
Ca^{++}	mg/L	23	192	14	48
Mg^{++}	mg/L	1.28	299	1.2	74
Na^{+}	mg/L	9	169	8.6	93
K^{+}	mg/L	0.5	34	0	4.7
$CO_3^{=}$	mg/L	0	35	0	30
HCO_3^{-}	mg/L	94	483	91.5	378
NO_3^{-}	mg/L	-	-	0.5	12
Cl^{-}	mg/L	10	1064	7.1	195
$SO_4^{=}$	mg/L	1	94	0	55
F^{-}	mg/L	0.19	2.5	0.24	1.7
Fe	mg/L	-	-	0	8.5
SAR	-	0.29	5.23	0.3	4

Based on the chemical analysis of water samples from different sources, it was observed that, almost all chemical parameters lie within permissible limit for drinking and irrigation purpose except few samples of some isolated pockets. For example, fluoride in excess of permissible limit has been found certain villages. The quality of ground water is generally good with EC ranging from 170 to 3720 µs/cm. The iso-conductivity map along with fluoride point values of phreatic (Aquifer-I) and deeper aquifer (Aquifer-II) of the district has been prepared and presented as **Fig. 3.7** and **3.8** respectively. It has been observed that, there are certain patches of high EC in the shallow aquifer, however in the deeper aquifer EC is generally low to medium and less than 1000 µS/cm.

Sodium hazard**:** For irrigation water the SAR value determines the sodium hazard as high sodium ions affects the permeability of soil and causes infiltration problems. The SAR value of the samples of Aquifer-I ranges from 0.29 to 5.23 and that of deeper aquifer ranges from 0.3 to 4. When SAR value is higher and within 3 to 9, it indicates slight to moderate sodium hazard and care should be taken for sensitive crops.

Salinity hazard**:** For the determination of salinity hazard and suitability of the ground water for the purpose of irrigation analysed in the *US-Salinity diagram* as shown in **Fig. 3.9** and **3.10**. The predominant USSL classes of the water samples fall within C2S1 and C3S1 classes.

Ground water facies**:** The water samples represent Ca-Mg-HCO_3 type to mixed facies of Ca-Mg-Na-HCO_3-Cl types as shown in the *Piper diagram* in **Fig. 3.11** and **Fig. 3.12** This indicates a transitional or mixing environment between the younger water and resident water.

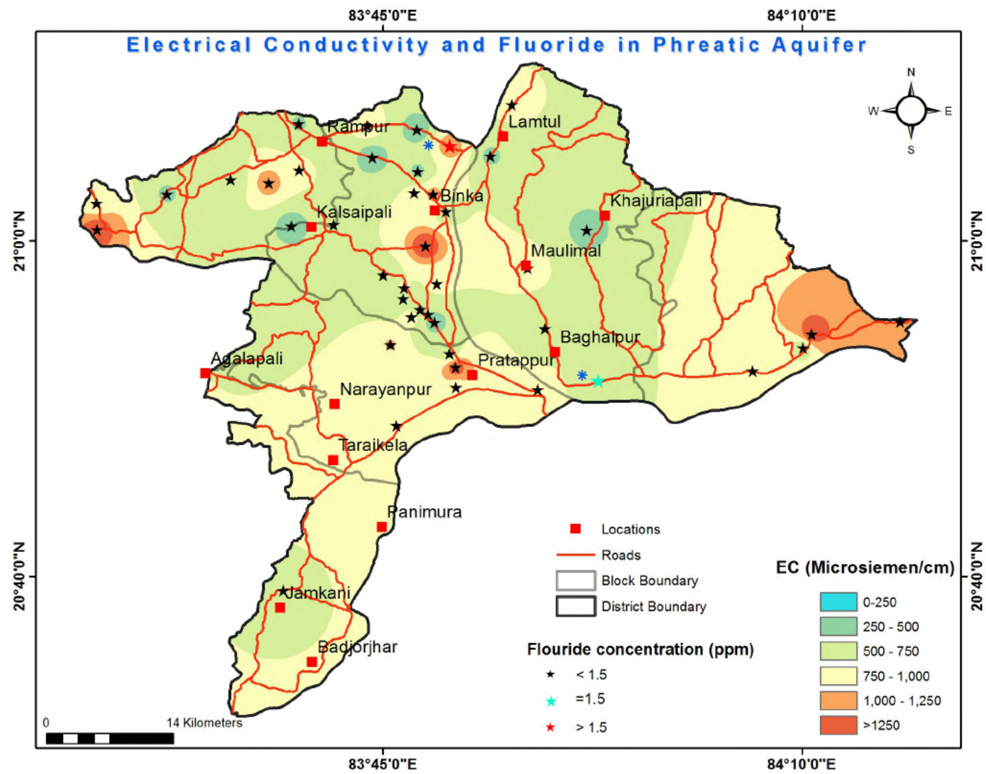


Fig. 3.7: Iso-conductivity Map and Fluoride in Phreatic Aquifer.

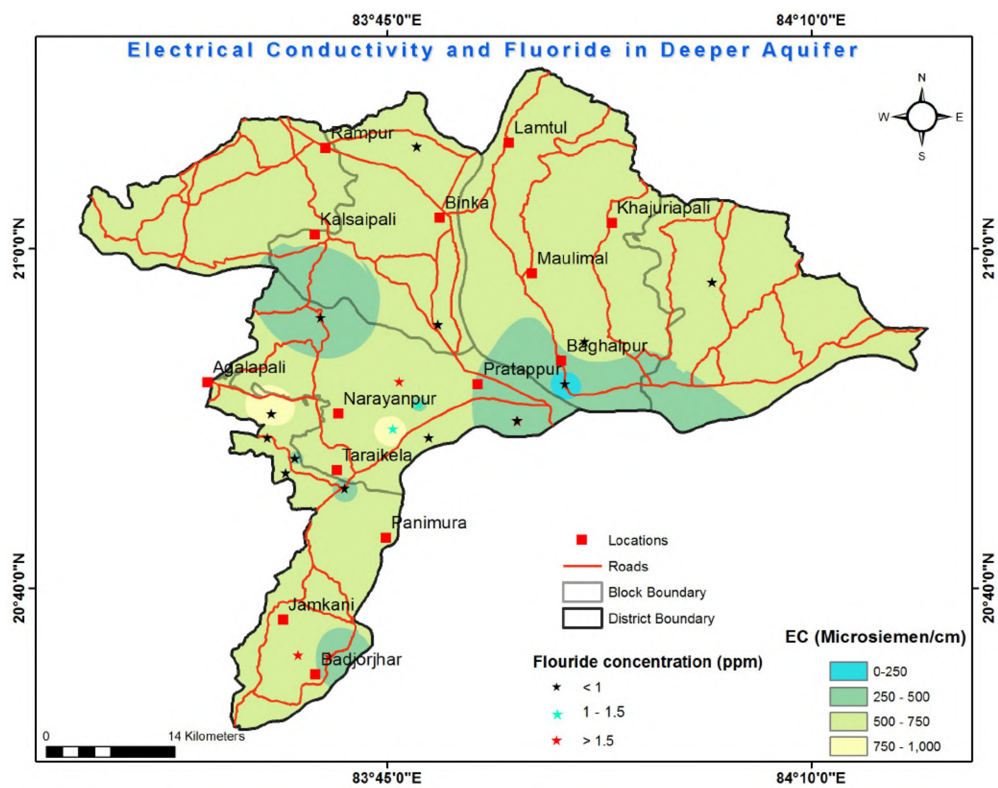


Fig. 3.8: Iso-conductivity Map and Fluoride in Fractured (Deeper) Aquifer.

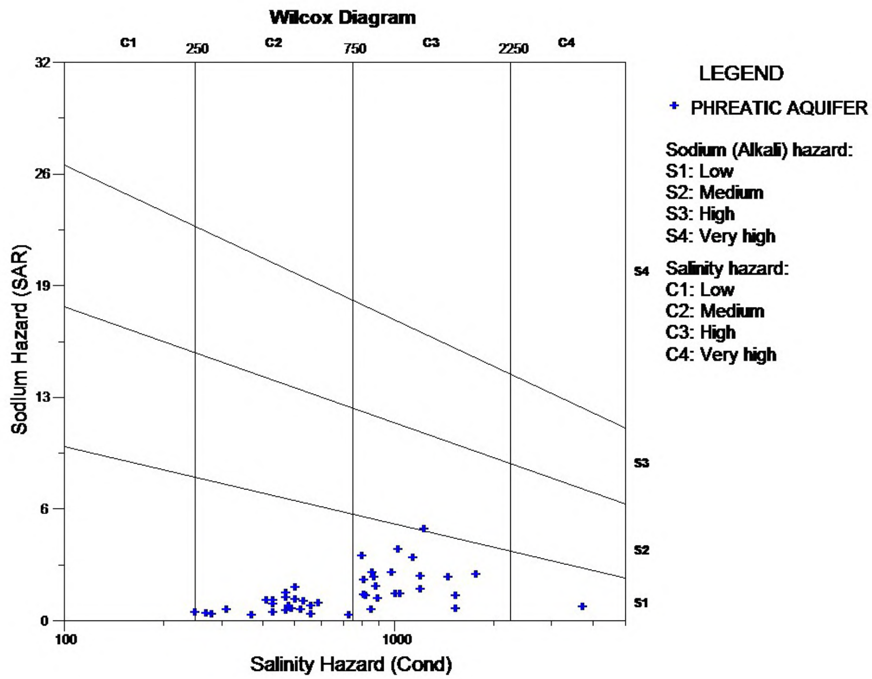


Fig. 3.9: US-Salinity Diagram, Phreatic Aquifer in Suvarnapur District.

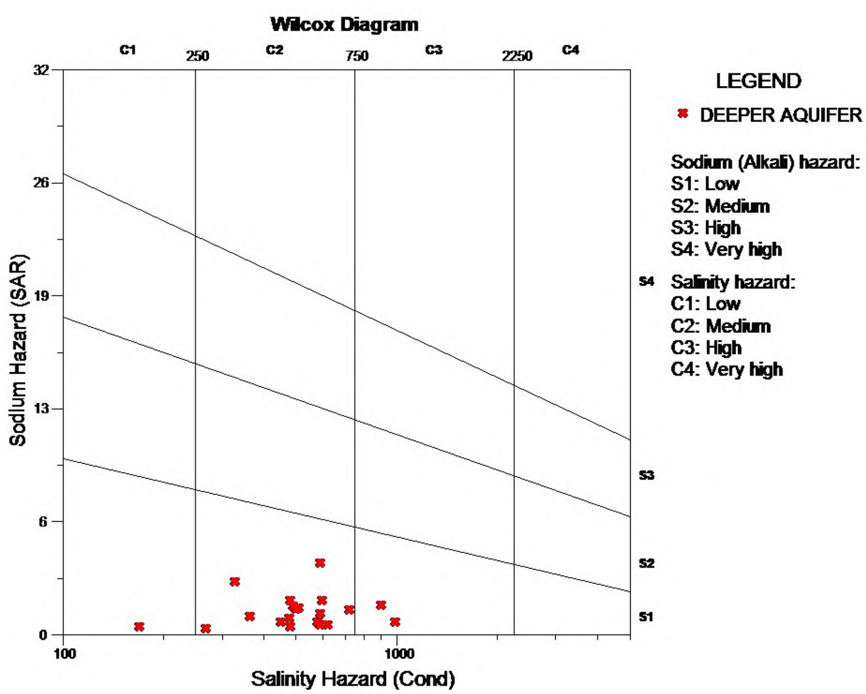


Fig. 3.10: US-Salinity Diagram, Deeper Aquifer in Suvarnapur District.

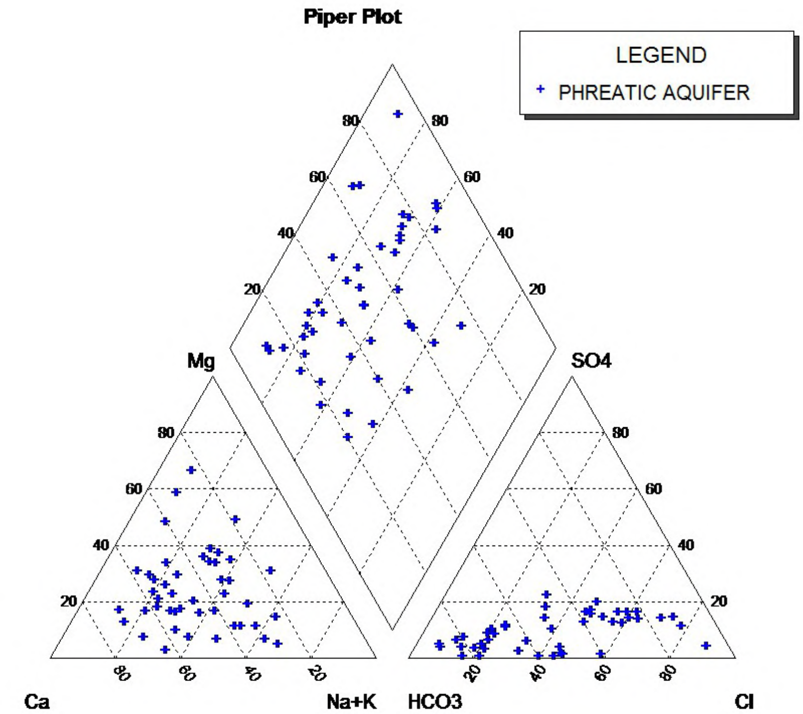


Fig. 3.11: Piper Diagram of Water Samples in Phreatic Aquifer, Suvarnapur District.

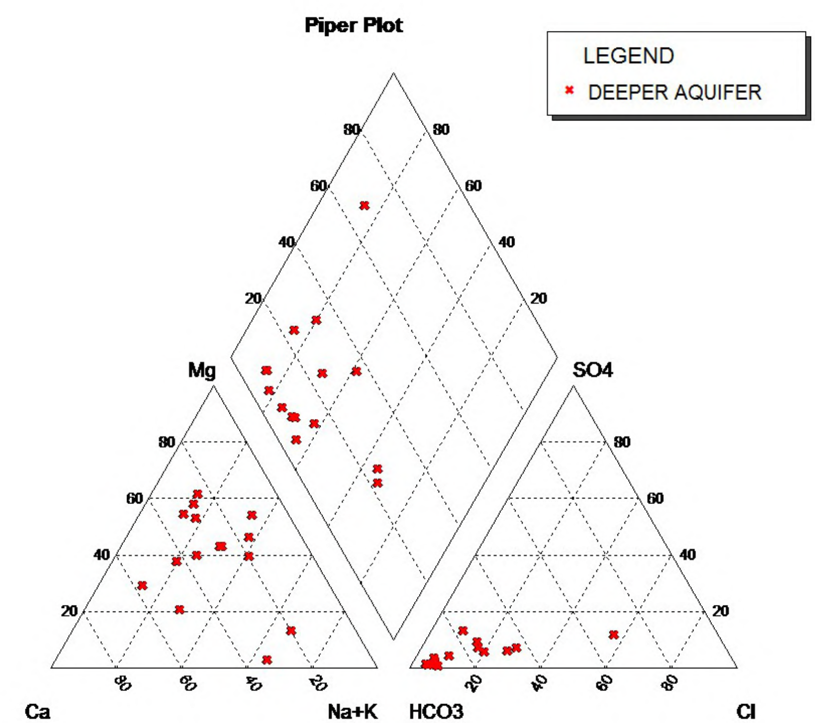


Fig. 3.12: Piper Diagram of Water Samples in Deeper Aquifer, Suvarnapur District.

3.4 Aquifer Groups and Their Demarcation

Based on extensive analysis of historical data, micro-level hydrogeological survey data generated and ground water exploration carried out in the area, the following two types of aquifers can be demarcated and the details are given below:

Aquifer- I (Unconfined Aquifer): Unconfined aquifer, occurs in entire area except the rocky outcrops, formed by the weathered mantle atop all crystalline as well as Gondwana formations and discontinuous alluvial tracts along major river channels. This aquifer generally occurs down to maximum depth of 50 mbgl. Based on field observations, isopach map of Aquifer–I is generated and shown in **Fig. 3.13.**

Aquifer-II (Semi-Confined to Confined Aquifer): Semi-confined to confined aquifer occurs as fracture zone aquifers in the entire area irrespective of rock types. However the aquifer properties, the yield of bore wells constructed in them depends on the rock type.

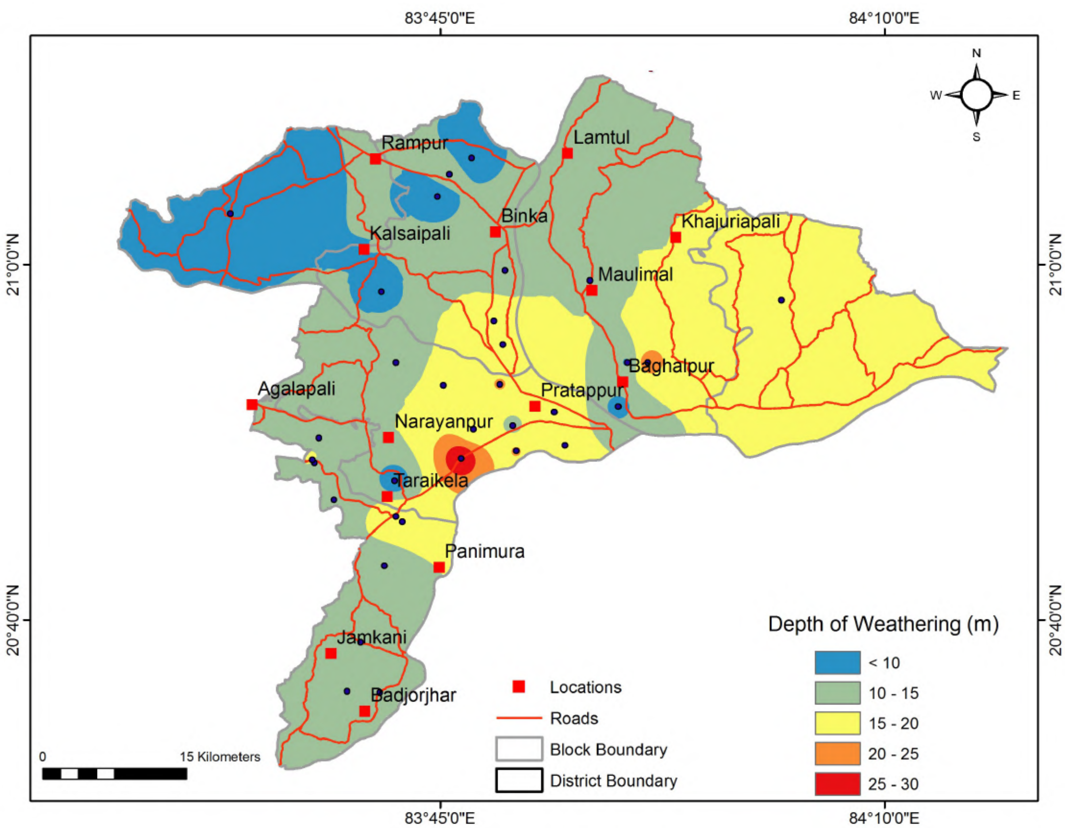


Fig. 3.13: Isopach of Weathered Zone (Aquifer-I) in Suvarnapur District.

As per the ground water exploration, carried out by CGWB, fractured granitic rocks have better yield in comparison to Gondwanas, charnockites and khondalites. In general, most of the fracture zones are encountered within 0 to 150 mbgl and seldom beyond that. Thus that maximum depth for the Aquifer-II has been taken as 200 mbgl.

The characteristics of the aquifer groups are summarized in **Table 3.4**.

Table 3.4: Characteristics of Aquifer Groups in Suvarnapur District.

Type of Aquifer Group	Formation	Depth range (mbgl)	Yield	Aquifer parameter	Suitability for drinking/ irrigation
Aquifer-I (Phreatic)	**Unconsolidated and Weathered** **Recent**: Soil, Alluvium & Laterite **Lower Gondwana**: Sandstone, **Pre-cambrian**: Granite Gneiss, Charnockite, Khondalite, Anorthosite	0-50	10-50 m^3/day	Specific Capacity Index: 0.5-40 lpm/m/m^2	Yes for both
Aquifer-II (Semi-confined to Confined)	**Fractured** Granite Gneiss, Charnockite, Khondalite, Anorthosites, Gondwanas,	50-200	Negl.- 14 lps	Transmissivity: 0.95-56.97	Yes for both

3.5 Aquifer Disposition

The ground water exploration data has been used to generate the 3D disposition of deeper alluvial aquifers. It comprises of all existing litho-units and the zones tapped during the ground water exploration, forming an aquifer. Based on the ground water exploration and micro-level hydrogeological survey data and aquifer delineation method, a schematic 3-D aquifer disposition is prepared and shown in **Fig. 3.14.** Five 2D schematic sections were drawn along lines A-A’, B-B’ and C-C’, which are shown in plan view in **Fig.3. 15** and the corresponding 2D schematic sections are shown in **Fig. 3.16**, **3.17** and **3.18**. A 3D Fence diagram is shown in **Fig. 3.19**.

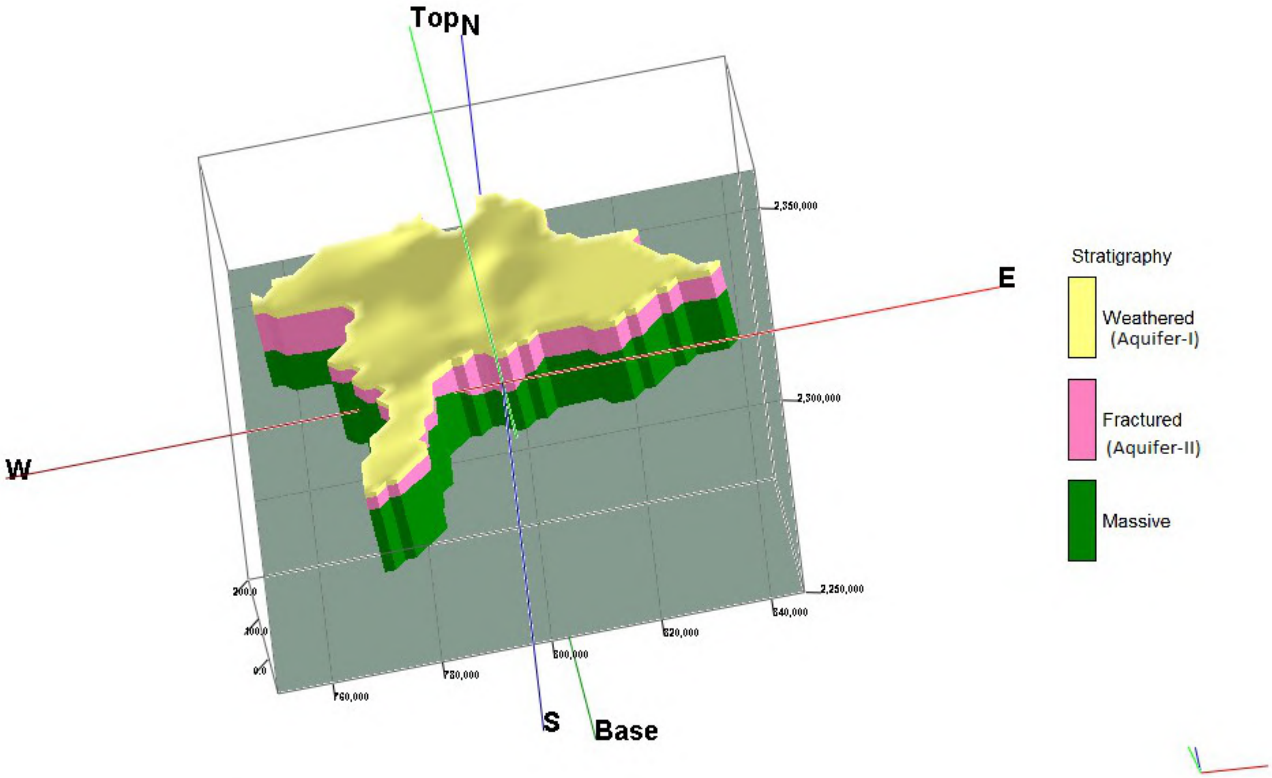


Fig. 3.14: Schematic 3D Aquifer Disposition in Suvarnapur District.

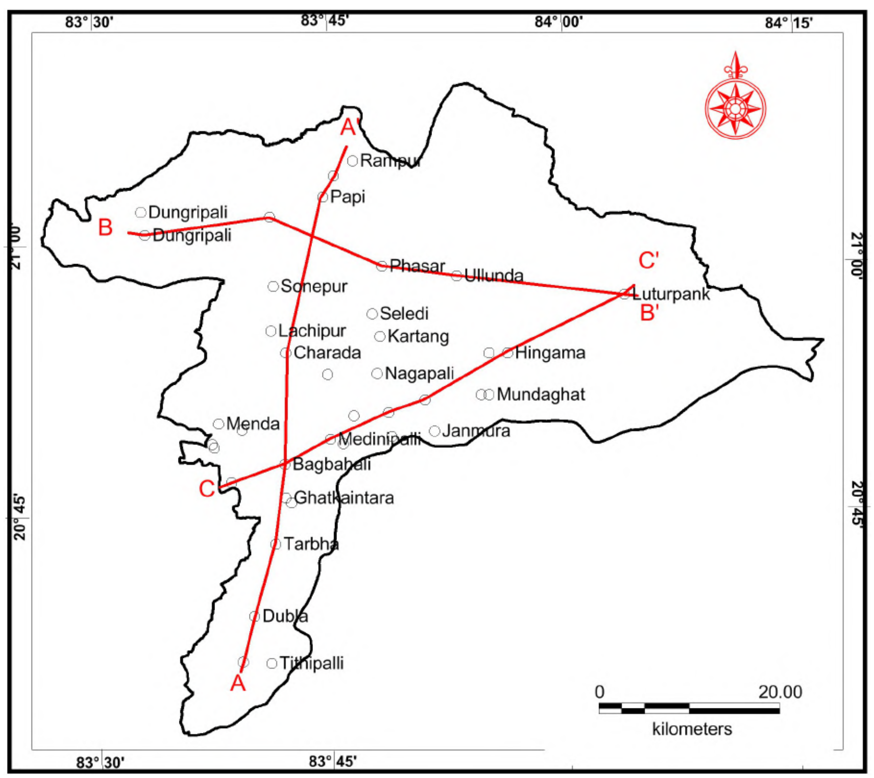


Fig. 3.15: Aquifer 2D Section Lines along A-A', B-B' and C-C'.

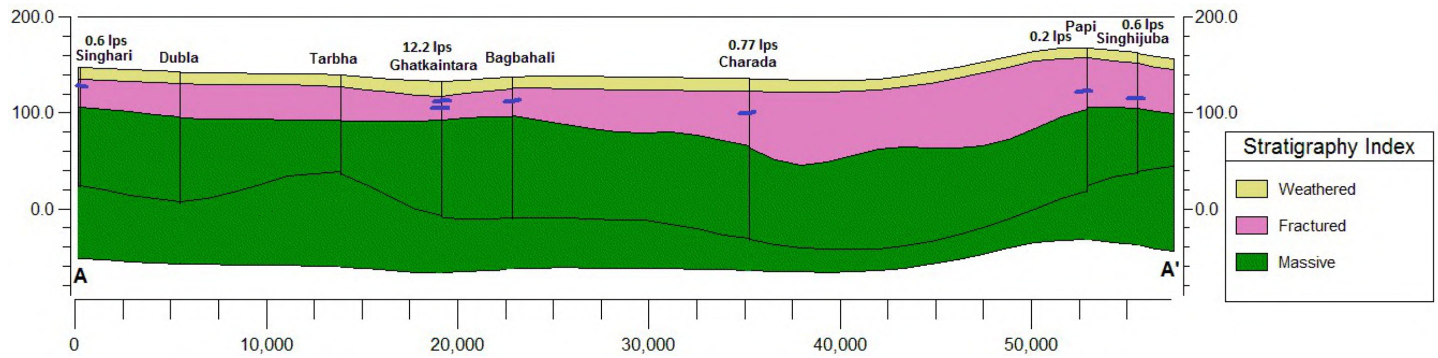


Fig. 3.16: Schematic Aquifer Cross-Section Along A-A' in Suvarnapur District.

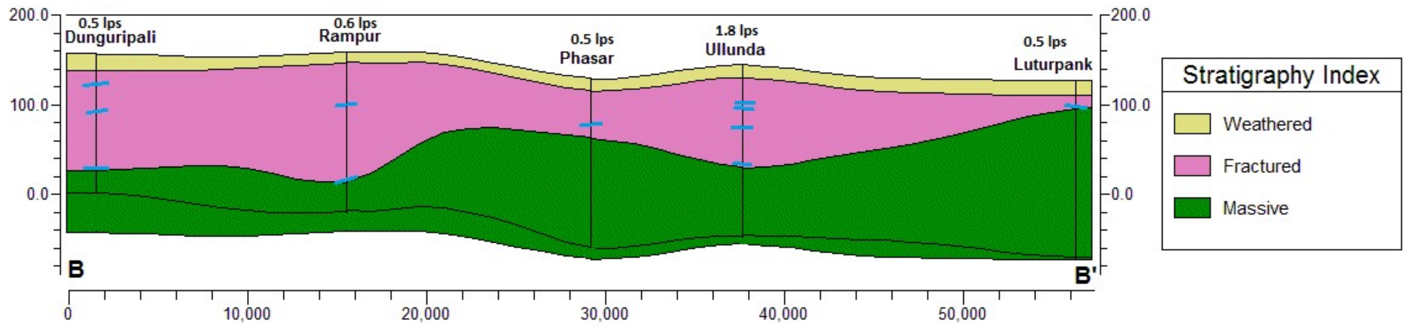


Fig. 3.17: Schematic Aquifer Cross-Section Along B-B' in Suvarnapur District.

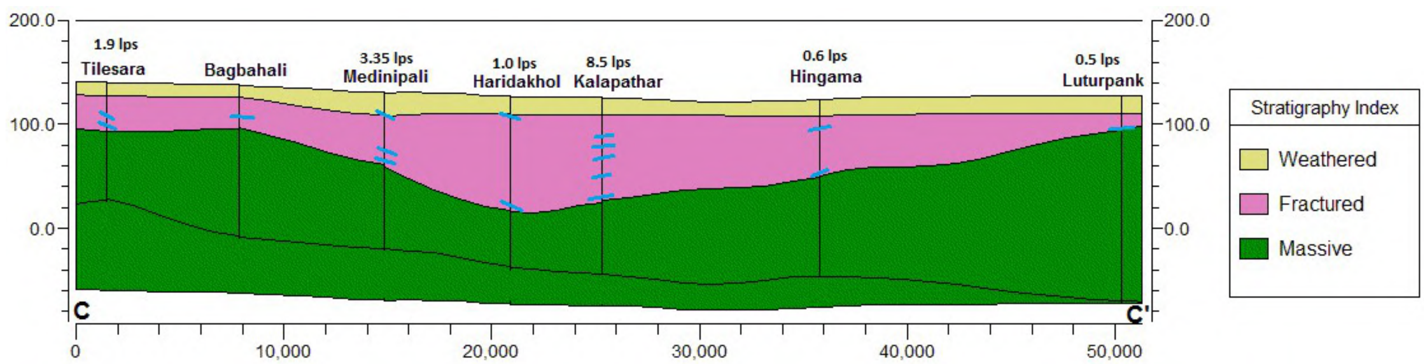
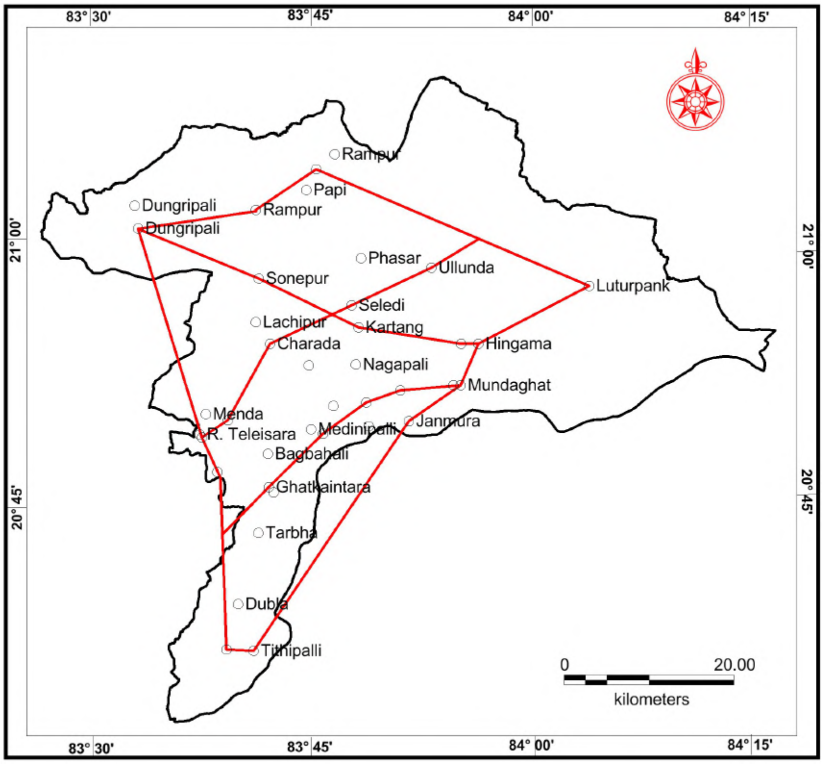


Fig. 3.18: Schematic Aquifer Cross-Section Along C-C' in Suvarnapur District.



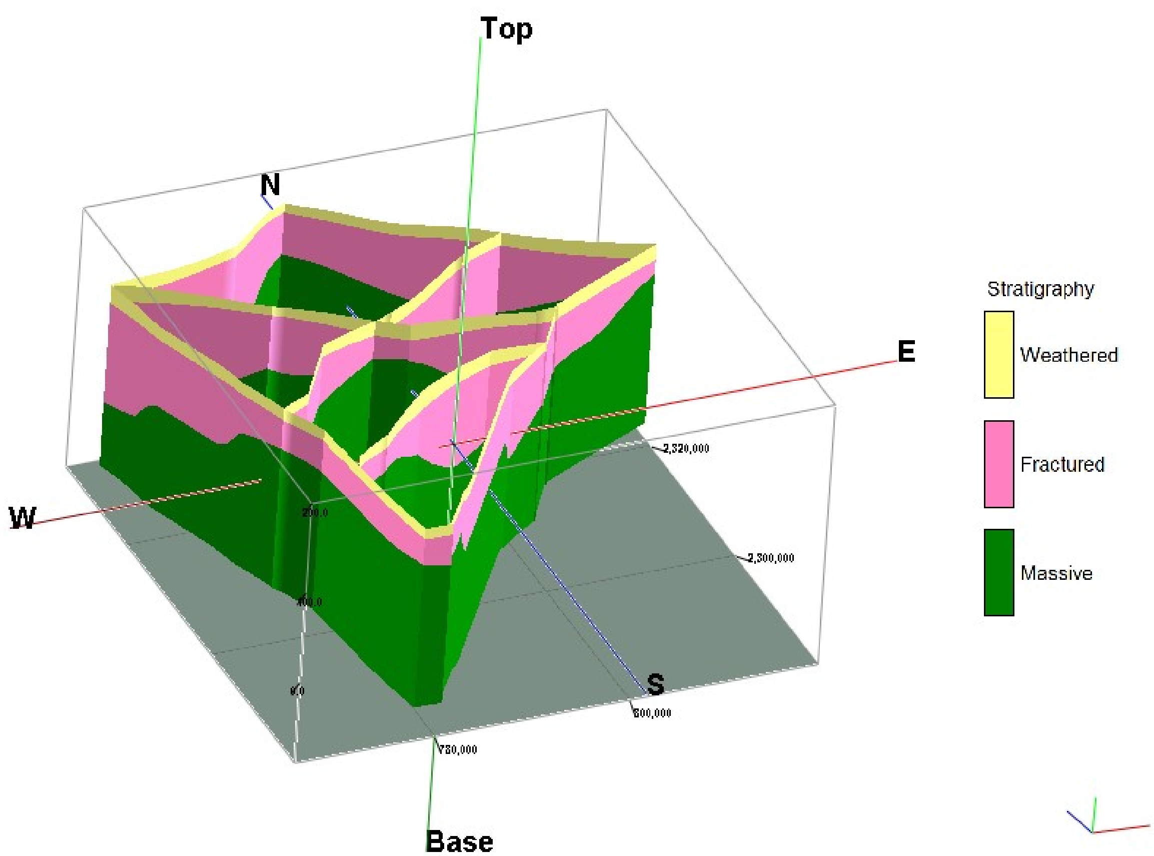


Fig. 3.19: Schematic 3D-Fence Diagram in Suvarnapur District.

4 GROUND WATER RESOURCES

The dynamic ground water resource of the district was jointly carried out in 2020 by Central Ground Water Board (CGWB) and Ground Water Survey and Investigation (GWS&I) adopting the methodology recommended by GEC 2015. The ground water resource can be aquifer wise divided into Dynamic and Static resource. The dynamic resource is the part of resource within the water level fluctuation zone which is also the annual replenishable resource. The resource below the water level fluctuation zone is termed as the In-storage (Static) resource. Mainly the water level fluctuation method was adopted for calculation of recharge. The block-wise resource of the aquifer mapping blocks as on 2020 is given below in **Table 4.1.**

Table 4.1: **Dynamic Ground Water Resources of Aquifer-I in Suvarnapur District. (2020)**

Sl No	Block	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for Irrigation	Existing Gross Ground Water Draft for domestic & Industrial Supply	Existing Gross Ground Water Draft for all uses	Annual ground water allocation for domestic water supply as on 2025	Net Ground Water Availability for future irrigation development	Stage of Ground Water Extraction
		(Ham)	(Ham)	(Ham)	(Ham)	(Ham)	(Ham)	(%)
1	Binika	3915.79	1037.04	346.1	1383.19	348.80	2516.69	35.3
2	Birmaharajpur	3397.56	1117.6	279.5	1397.12	289.08	1986.46	41.1
3	Dunguripali	3532.76	927.12	342.2	1269.31	349.16	2249.86	35.9
4	Sonepur	4603.06	2811.82	376.3	3188.11	389.31	1379.82	69.3
5	Tarbha	4033.65	2265.52	300.2	2565.69	324.93	1437.76	63.6
6	Ullunda	5302.65	1225.26	268.6	1493.87	286.77	3783.99	28.2
	Total	**24785.47**	**9384.36**	**1912.9**	**11297.29**	**1988.05**	**13354.58**	**45.58**

The combined net ground water available is 24785.47 Ham and gross annual draft is 11297.29 Ham. The stage of ground water extraction is minimum for Ullunda block which is 28.2 %. The highest ground water extraction is in Sonepur block that is 69.3 % and all the blocks are in Safe category.

The in-storage resources are calculated for Aquifer-I and II separately. However the semi-confined to confined deeper aquifers have been connected to the unconfined aquifer through the fractures and receive continuous recharge. The In-storage ground water resources of Aquifer-I are given in **Table 4.2** and the total resources of Aquifer-I in **Table 4.3** below.

Table 4.2: In-Storage Ground Water Resources of Aquifer-I in Suvarnapur District.

Sl No	Block	Assessment Area	Bottom Depth of Aquifer	Average Pre-monsoon Water Level	Total Effective Saturated Thickness (2-3)	Average Specific Yield	In Storage Ground Water Resources [(1)*(4)*(5)]
		(Ha) (1)	(mbgl) (2)	(mbgl) (3)	(m) (4)	(5)	(Ham) (6)
1	Binika	34489	50	5.35	44.7	0.02	30798.7
2	Birmaharajpur	40811	50	6.79	43.2	0.02	35268.9
3	Dunguripali	29118	50	3.31	46.7	0.03	40785.6
4	Sonepur	38517	50	5.46	44.5	0.03	51466.4
5	Tarbha	32693	50	8.2	41.8	0.03	40997.0
6	Ullunda	56426	50	5.69	44.3	0.03	75007.1
	Total	**232054**					**274323.7**

Table 4.3: Total Ground Water Resources of Aquifer-I in Suvarnapur District.

Sl No	Block	Dynamic Resource	In Storage Resource	Total Ground Water
1	Binika	3915.79	30798.7	34714.5
2	Birmaharajpur	3397.56	35268.9	38666.5
3	Dunguripali	3532.76	40785.6	44318.4
4	Sonepur	4603.06	51466.4	56069.5
5	Tarbha	4033.65	40997.0	45030.7
6	Ullunda	5302.65	75007.1	80309.8
	Total	**24785.47**	**274323.7**	**299109.4**

The in-storage ground water resource in Aquifer- II i.e. the semi-confined to confined aquifer is shown in **Table 4.4**.

Table 4.4: In-Storage Ground Water Resources of Aquifer-II in Suvarnapur District.

Sl No	Block	Assessment Area (Ha)	Top Depth of Aquifer (mbgl)	Bottom Depth of Aquifer (mbgl)	Total Satu-rated Thickness (m)	Productive Zone (5% of Total Thickness) (m)	Avg. Sp. Yield	In Storage Ground Water Resources (Ham)
		(1)	(2)	(3)	(4)=(3-2)	(5)	(6)	(7)=(1*5*6)
1	Binika	34489	50	200	150	7.5	0.02	5173.4
2	Birmaharajpur	40811	50	200	150	7.5	0.02	6121.7
3	Dunguripali	29118	50	200	150	7.5	0.03	6551.6
4	Sonepur	38517	50	200	150	7.5	0.03	8666.3
5	Tarbha	32693	50	200	150	7.5	0.03	7355.9
6	Ullunda	56426	50	200	150	7.5	0.03	12695.9
	Total	**232054**						**46564.8**

Ground Water Abstraction Structures Feasible: The feasible ground water structures and probable yield in different geological units in Suvarnapur district is given below:

Granite and Granite Gneiss: Ground water occurs in weathered horizon in unconfined condition, yield of dug well upto 50 m3/day; Deeper fracture zones - yield of bore wells within 2.0 lps, occasionally upto 5 lps.

Charnockites: Ground water in weathered zone in unconfined condition, yield of dug wells upto 30 m^3/day; Deeper fracture zones- yield of bore wells less than 1 lps

Khondalites: Ground water in weathered zone in unconfined condition, yield of dug wells upto 50 m^3/day; Deeper fracture zones- yield of bore wells less than 1 lps

Anorthosites: Ground water in weathered zone in unconfined condition, yield of dug wells upto 50 m^3/day; Deeper fracture zones- yield of bore wells less than 1 lps

Lower Gondwana: The semi-consolidated sandstones are friable and exhibit well developed bedding planes and open joints. The yield potentials of dugwells up to 20 m^3/day. Shallow tube wells yield less than 1 lps.

5 AQUIFER MANAGEMENT PLAN

The highly diversified occurrence and considerable variations in the availability and utilization of groundwater makes its management a challenging task. Scientific development and management strategy for groundwater has become imperative to avert the looming water crisis. In this context, various issues such as, prioritization of areas for development of groundwater resources vis-a-vis its availability, augmentation of groundwater through rainwater harvesting and artificial recharge, pricing and sectoral allocation of resources and participation of the stakeholders must be considered.

5.1 Ground Water Related Issues

5.1.1 Under Utilisation of Ground Water Resources

As per the ground water resource estimated jointly by CGWB and State Govt. in 2020, the Net Ground Water Availability of Binika, Birmaharajpur, Dungripali and Ullunda are 3915.79, 3397.56, 3532.76 and 5302.65 ham respectively. The stages of ground water development are 35.3, 41.1, 35.9 and 28.2 % respectively. Thus there exists sufficient scope for further ground water development in these blocks.

5.1.2 Less Productive Deeper Aquifer

The exploratory drilling in the district reveals that the deep fractured aquifer is less productive. Many of the borewells drilled in the district have very poor discharge. The failure rate of borewells is very high in the Easternghat Group of rocks like the anothosites, charnockites and khondalites. Granitic formations have comparatively better yield prospect for laying bore wells.

5.1.3 Water Logging Problem

Water logging conditions have been observed in parts of Dungripali and Binika blocks which form a part of Hirakud Command area, where water level is within 2m below from ground surface. Low topography, unlined canals, indiscriminate application of canal water and the prevailing paddy cultivation in both Kharif and Rabi seasons are mainly responsible for the water logging. These areas are in the tail end of the Hirakud canal command on Mahanadi river.

5.1.4 Depleted Water Level in Phreatic Aquifer

Ground water level in the phreatic aquifer is found to be deep in many parts of Suvarnapur district. Depth to water level during pre-monsoon periods is deeper (4-8 mbgl) in most of the Birmaharajpur, Ullunda, Sonepur and Tarbha blocks. However, during the post-monsoon water level rises in most of the districts and remain within 2-4 mbgl excluding small patches. The decadal trend of water level is negative in eastern and southern part of Birmaharajpur and Tarva blocks respectively and in the northern part of the district covering parts of Binka and Dungripali blocks. Thus long-term change in water level is not so significant. The deeper level during the pre-monsoon indicates ground water scarcity in the areas during the summer months. But shallow post-monsoon water level in most parts of the district indicates that, the natural replenishment of phreatic aquifer during rainy season is adequate.

5.2 Aquifer Management Plan

5.2.1 Demand Vs Supply Scenario of Water

The water demand and supply scenario of the district is shown in **Table 5.1.**

Table 5.1: Water Demand and Supply Scenario in Suvarnapur District.

Block	Existing Water Demand (MCM)				Water Supply for Irrigation (MCM)			Demand-Supply Gap For Irrigation (MCM)	Further Ground Water Development Potential (MCM)
	Domestic	Livestock	Irrigation	Total	Surface Water	Ground Water	Total		
Binika	3.71	2.45	188.63	194.79	171.46	10.37	181.83	13.0	9.66
Birmaharajpur	3.88	2.89	187.37	194.14	39.46	11.18	50.64	143.5	6.41
Dungripali	5.05	2.57	223.62	231.24	215.07	9.27	224.34	6.9	8.50
Sonepur	3.29	1.3	145.48	150.07	23.75	28.12	51.87	98.2	**Nil**
Tarbha	3.44	1.86	217.7	223	11.54	22.66	34.2	188.8	**Nil**
Ullunda	3.66	2.22	161.5	167.38	69.25	12.25	81.5	85.9	16.87
Total	**23.03**	**13.29**	**1124.3**	**1160.62**	**530.53**	**93.85**	**624.38**	**536.3**	**41.44**

Source: District Irrigation Plan of Suvarnapur, DLIC Suvarnapur, March 2016

The water demand domestic and livestock use is 36.32 MCM, calculated for the year 2020, which is about 3% of the total water demand. From the table above it’s evident that the gap in irrigation is 536.3 MCM which accounts for the water requirement of rainfed and unirrigated crops. Further ground water potential is calculated and taken from **Table 5.2**. Thus, about 8% of the irrigation water gap can be filled up by further utilizing the available ground water resource.

Proposed Demand Side Interventions: There is very little scope for the demand side interventions as the district experiences acute shortage of water during the lean seasons. But for the sustainability of the present scenario and for enhancing the agriculture production, the following demand side interventions can be suggested:

1. Optimization of irrigation water requirement by use of water efficient farm techniques such as drip, sprinkler and mulching.
2. Switching over cropping pattern from water intensive paddy to green gram, wheat or millets in high and mid land areas.

Proposed Supply Side Interventions: As already discussed, only ground water cannot meet the future irrigation demand of the district. Thus following supply side measures are suggested:

1. Further ground water development in under-utilized blocks Binika, Birmaharajpur, Dungripali and Ullunda, the details of which are discussed in section 5.2.2.
2. Creation of additional surface water irrigation potential through river lift water schemes and minor irrigation projects.
3. Enhancement of surface and ground water storage through rain water harvesting and artificial recharge.

5.2.2 Management Plan for Under-Utilisation of Ground Water

For the supply side intervention, further development of ground water resource is possible as there is sufficient scope for this is available in four blocks of the district viz. Binika, Birmaharajpur, Dungripali and Ullunda. The present ground water extraction rate in these blocks ranges from 28.2 % to 41.1 %. The quantum of water available for extraction from the phreatic aquifer is thus calculated, keeping the percentage of ground water development within 60%. The same is shown in the **Table 5.2**. The calculations are based on, unit draft for dug well taken as 0.96 Ham and the irrigation potential per dug well taken as 2 Ha at an estimated 200% cropping intensity. Thus additional 4319 structures are feasible with irrigation potential of 8638 Ha in these blocks.

Table 5.2: Ground Water Development Potential of Suvarnapur District.

Block	Net Ground Water Availability (Ham)	Stage of Ground Water Development in 2020 %	Present Ground Water Draft (Ham)	Ground Water draft at 60% Stage of development (1)*0.6 (Ham)	Surplus Ground Water at Present Stage of development (4)-(3) (Ham)	Number of additional structure feasible for irrigation use assuming unit draft as 0.96 ham per Dug Well (Number)	Additional irrigation potential to be created (2.0 ha per Dug Well) (Ha)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Binika	3915.79	35.3	1383.19	2349.47	966.284	1007	2014
Birmaharajpur	3397.56	41.1	1397.12	2038.54	641.416	668	1336
Dunguripali	3532.76	35.9	1269.31	2119.66	850.346	886	1772
Ullunda	5302.65	28.2	1493.87	3181.59	1687.72	1758	3516
Total	**16148.76**		**5543.49**	**9689.26**	**4145.766**	**4319**	**8638**

5.2.3 Management Plan for Less Productive Deeper Aquifer

Selection of proper site for drilling of bore wells, based on the favourable hydrogeological conditions has to be done. As discussed earlier, a lot of scope exists for ground water development. Priority should be given to the phreatic aquifer for extraction of ground water through large diameter dugwells and dug-cum-borewells at hydrogeologically suitable locations.

In Tarbha block, the main rock types are anorthosite, gabbro and khondalites, the failure of bore wells is quite common. However it has been observed that, at places the weathered anorthosite form potential pheatic aquifers providing good yield in the dugwells mostly near big ponds. In general, the shallow medium black clayey soil layer does not facilitate ground water recharge. In these ponds, due to the excavated clay layer, the phreatic aquifer easily gets recharged and provide yield to the dugwells. Hence construction of farm ponds in such areas is a viable option for recharging and tapping the phreatic aquifer.

From the isopach map shown in **Fig. 3.13**, it’s evident that the depth of weathering in Suvarnapur district is generally more than 10 mbgl and in the blocks Birmaharajpur, Sonepur and southern parts of Binka and Ullunda, the weathering depth is more and within 15 to 25 mbgl. Thus the pheatic aquifer has a large storage capacity, which can be utilized for ground water extraction as well as recharge.

5.2.4 Management Plan for Water Logging

In Hirakud command area, development of ground water is feasible through dug wells and bore wells. Dug wells are more suitable ground water structure in the area. For better management of surface and ground water and rectifying water logging problem, their conjuctive use is needed. A pilot study had been taken up previously by CGWB in Hirakud command area, through which ground water development plan had been brought out through ground water flow modeling. The demand of water for 200% cropping intensity can be met from surface water (90%) and ground water (10%) for both the seasons. The existing cropping pattern needs modification. Diversification of crops from paddy to non-paddy crops like oil seed, pulses, vegetables during rabi season, at least in high and medium land areas is essential.

5.2.5 Management Plan for Depleted Water Level in Phreatic Aquifer

The problem of water level depletion in the phreatic aquifers can be addressed through artificial recharge through various water conservation structures. However, as already discussed, water level between 2-4 mbgl during post-monsoon period in most of the district shows adequate natural recharge and replenishment of phreatic aquifer. But there is still a lot of scope for artificial recharge to address the sustenance of phreatic aquifer to address the summer period water crisis due to deepening of water level. All the existing 1st order streams are suitable for construction of nala bunds. Similarly 2nd and 3rd order drainages are suitable for the construction of check dams. For the mitigation of deeper water level areas in the district, the following measures can be taken up:

1. Contour trenching, staggered trenching and gabian structures to arrest the surface runoff in foot-hill areas.
2. Construction of farm ponds and renovation of existing water bodies.
3. Construction of 18 percolation tanks, 65 check dams can be done.

The proposed sites for artificial recharge structures are shown in **Fig. 5.1**.

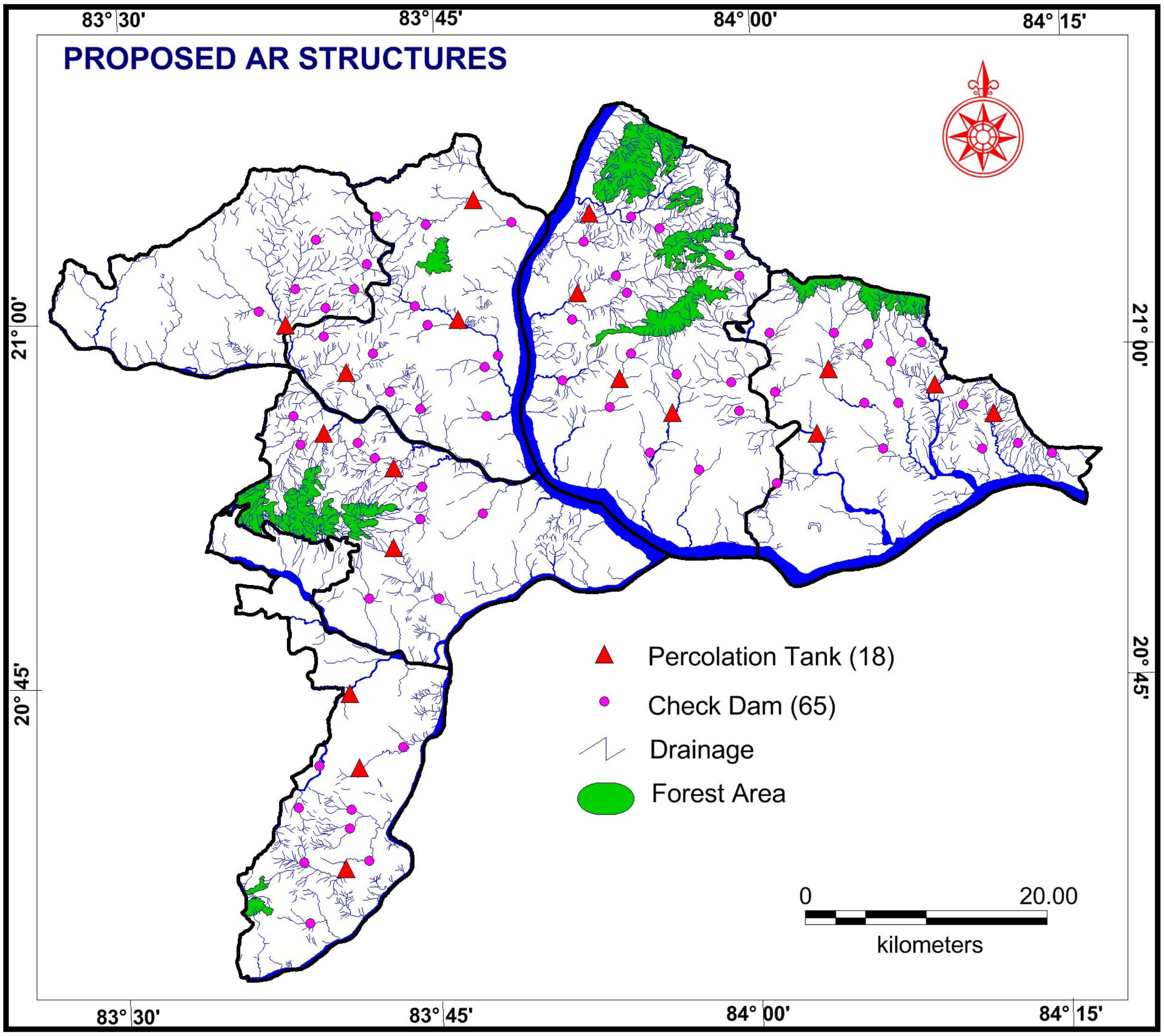


Fig. 5.1: Tentative sites for Artificial Recharge Structures Proposed in Suvarnapur District.

6 SUMMARY AND RECOMMENDATIONS

6.1 Summary

National Aquifer Mapping Programme (NAQUIM) was taken up for detailed hydrogeological investigation, data-gap analysis and Aquifer Mapping and Management in the district of Suvarnapur, covering 6 blocks of Binika, Birmaharajpur, Dunguripali, Sonepur, Tarbha and Ullunda during the period 2019-2020. The following are the summarised details.

1 The study area lies between 83°26’11” E and 84°17’19” E longitudes and 20°31’50” N and 21°10’05” N latitudes covering 2337 sq. Km. of geographical area under the SOI Toposheet Numbers 64 O/8, 12, 16; 64 P/5, 9, 10, 13, 14; 73 C/4 and 73 D/1. The NAQUIM mappable area is 1969 sq. Km which was taken up for the study after excluding the hilly areas.

2 The district is having 2 Subdivisions (Birmaharajpur and Sonepur), 6 administrative blocks (Binika, Birmaharajpur, Dungripali, Sonepur, Tarva and Ullunda), 4 towns (Sonepur Town - Municipality, Tarva Town - NAC and Binika Town – NAC and Subalaya-Census Town), 96 Gram Panchayats and 962 villages.

3 The normal annual rainfall of the district is 1418.5 mm. Normal rainfall has been received in 36% to 70 % of the years during the period 1989-2018.

4 The area forms a part of Mahanadi Basin. The other major rivers are Tel and Ong.

5 The area covered by forest in the district is 17.5%. The net area sown is 51.7% with cropping intensity of 190 % (2013-14).

6 Two types of soil are found in the district viz. Alfisol and Vertisols.

7 Hariharjor Irrigation Project is the only Medium Irrigation Project existing in Birmaharaj block with designed irrigation potential of 9450 Ha. There are 794 LI projects with designated ayacut area of 20213 ha out of which 751 projects are in operation and they irrigate 18297 ha. There are total 58 MIPs with irrigation potential of 7755 Ha.

8 The district is underlain by Easternghat suite of rocks, Lower Gondwana formations and Alluvial formations.

9 The crystalline formations like charnockite, khondalite, anothosite and granite gneiss are classified as consolidated water bearing formations. Here ground water exists in unconfined conditions in the weathered mantle and in semi-confined to confined conditions in deeper fractured aquifers. The friable and loosely connected sandstones form aquifer. The alluvium on major river courses and valley fill deposits are classified under Unconsolidated formations.

10 CGWB has constructed 35 EWs, 7 OWs and 4 PZs during the departmental ground water exploration programme. Apart from that, 24 Nos. EWs were drilled under Accelerated Exploratory Drilling Programme (AEDP), Phase-I and II during the year 2001. For the monitoring of ground water level and quality CGWB has established 55 National Hydrograph Network Stations (NHNS) in the district.

11 The discharge of successful borewells varies from 0.20 lps (Sonepur) to a maximum of 14 lps (Chun Chun Dungripali). Generally 1 to 4 potential fracture zones are encountered within the depth range of 200 m.

12 Depth to water level in pre-monsoon period (April 2019) varies from 0.77 to 7.6 mbgl, the average being 4.45 m bgl. Depth to water level in post-monsoon period (Nov 2019) varies from 0.95 to 5.09 mbgl, the average being 2.66 m bgl. The seasonal fluctuation of ground water table between pre and post monsoon period in the study area varies from -1.12 to 5.67 m. The decadal water level trend analysis indicates that out of 32 stations, 14 show rising and 18 show falling trend during pre-monsoon and 12 show rising and 20 show falling trend during post-monsoon seasons.

13 The chemical quality of ground water both from shallow and deeper aquifers are good and can be suitably utilised for domestic as well as irrigation purposes.

14 The estimated dynamic ground water resource is 24785.47 Ham and the stages of extraction of ground water range from 28.2 to 69.3 %. The ground water development is minimum in Ullunda block and maximum in the Sonepur block.

6.2 Recommendations

For a sustainable ground water development in the area, a systematic, economically sound and politically feasible framework for groundwater management is required. Considering the local physiographical and hydrogeological set up the following ground water management strategy is suggested.

1 Proper guidance has to to be provided to the farmers siting proper ground water structure in favourable hydrogeological setting.

2 Priority should be given to the phreatic aquifer for extraction of ground water through large diameter dugwells and dug-cum-borewells at hydrogeologically suitable locations. Selection of proper site for drilling of bore wells, based on the favourable hydrogeological conditions has to be done.

3 For the irrigation requirement in relatively water deficient areas, efficient irrigation techniques such as drip and sprinkler should be practiced.

4 In the foot hill regions, contour trenching, staggered trenching along with gabian structures should be constructed to arrest the surface runoff and improve rainfall recharge.

5 Artificial recharge projects may be taken up in the district especially in hard rock areas for augmentation of ground water resources through construction of percolation tanks, check dams, farm ponds. As the deeper aquifer is usually less productive, injection wells are not feasible.

6 Conjunctive use of surface and ground water is must in the command areas.

7 Rain water harvesting should be adopted in all govt. and public buildings.

8 The farmers should be educated through agricultural extension services for adopting suitable cropping patterns for optimal utilization of available ground water and surface water resources.

9 Industrial waste waters and effluents should be treated and disposed off properly under an effective monitoring mechanism.